A REVIEW OF THE ELOPOID AND CLUPEOID FISHES OF THE RED SEA AND ADJACENT REGIONS

BY

P. J. P. WHITEHEAD

Department of Zoology, British Museum (Natural History)

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INTRODUCTION

Fishes of the suborders Elopoidei and Clupeoidei are amongst the most important in world fisheries today. In tropical seas a much greater number of species occur and are exploited than in temperate regions, and biological knowledge of economically important species is often, as a result, hindered by a lack of adequate faunal lists and by problems of systematics. The Red Sea is, in this respect, one of the least studied areas in the Indo-Pacific region, although knowledge of the fishes goes back to the time of Forskål. In his *Descriptiones Animalium*, Forskål (1775) lists

four Red Sea species now placed in the suborders Elopoidei and Clupeoidei (*viz. Elops machnata, Albula vulpes, Chirocentrus dorab* and *Thrissina baelama*). The number of such Red Sea species has grown steadily. Rüppell (1837) lists nine, Klunzinger (1871) six, Steindachner (1907) eleven, and Fowler (1956), in the most recent and comprehensive list, includes some thirty-two species (some from the Persian Gulf only). I have here found certain records of only seventeen species

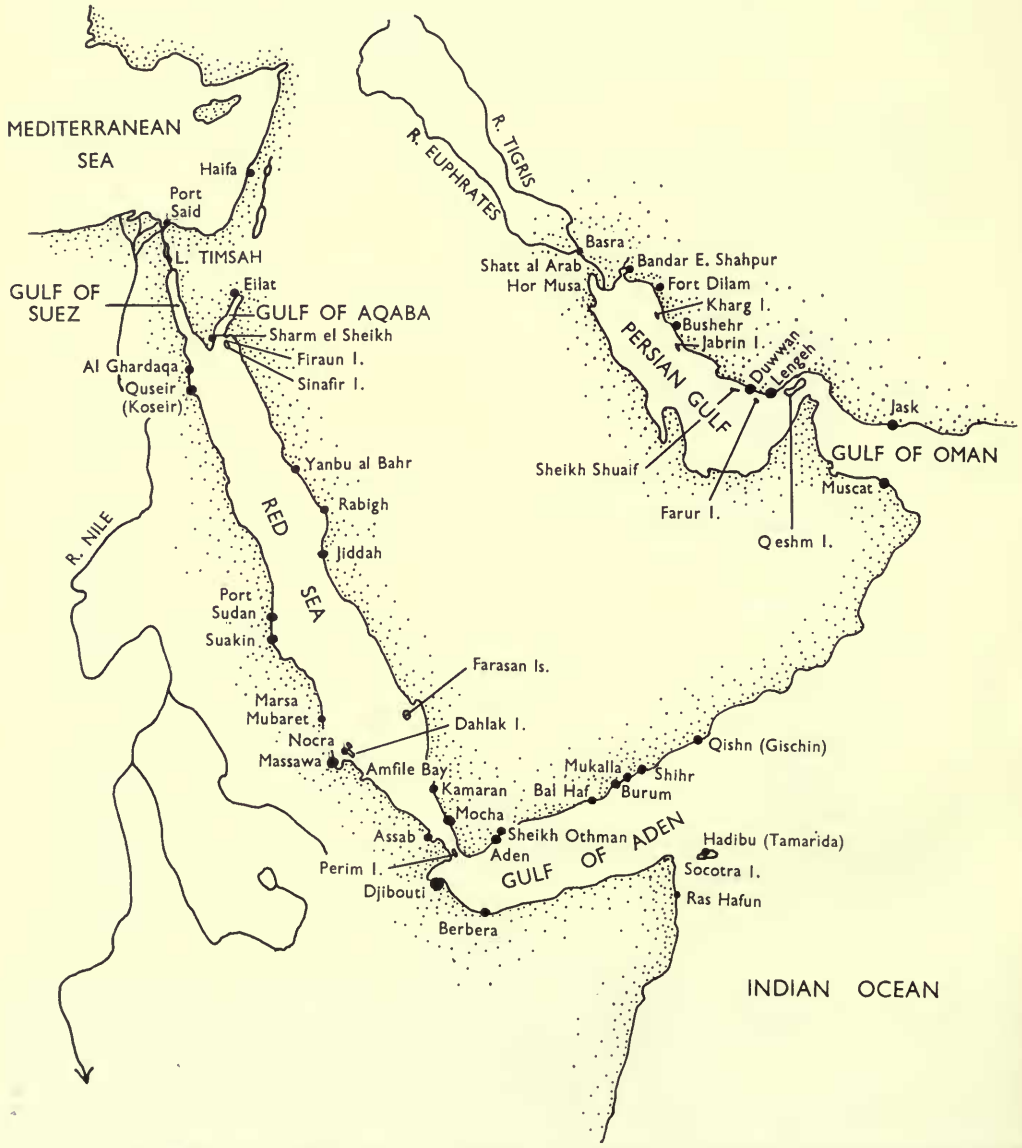

FIG. 1. Sketch map of Red Sea and Persian Gulf region. Spelling follows that of the Times Atlas (1959).

from the Red Sea itself, but a further twelve species occur either in the Persian Gulf. the Gulf of Oman, or the Gulf of Aden. Two other species, of Mediterranean origin, are recorded from the Suez Canal.

Collections of Red Sea material are on the whole small, and are scattered amongst a number of museums. It was a pleasure, therefore, to be able to examine, through the courtesy of Professor H. Steinitz, the elopoid and clupeoid material collected by the Israel South Red Sea Expedition (see Oren 1962) deposited at the Hebrew University. In addition, Professor Steinitz kindly offered further Red Sea material collected previous to this, mainly from the Gulf of Aqaba. The list of species represented by these collections was large enough to justify a review of all Red Sea species, and for this reason material has been examined from this museum and borrowed from other institutions. This material includes certain of Rüppell's specimens from the Red Sea, some of Blegvad's (1944) fishes from the Persian Gulf, part of an important and hitherto unrecorded collection made by Fraser-Brunner in the Gulf of Aden, fishes collected by Marshall (1950) in the Gulf of Aqaba, some of Steindachner's Arabian specimens, as well as fishes from smaller collections.

The aim of this review has been to establish the identity of previous records from the Red Sea region in the light of more recent systematic studies than were available to Fowler, and to include material collected since 1956 but for the most part not yet reported on. Even now, there is insufficient material for comparisons to be made between forms from different parts of the Red Sea region ; indeed, only seven species are common to both the Red Sea and the Persian Gulf, and in each case the specimens from the Persian Gulf are too few for a valid comparison to be made. Equally, comparisons between the Red Sea form and the form found in other parts of the Indo-Pacific region are largely limited by poor descriptions relating to the latter area. It is clear, however, that amongst the elopoid and clupeoid fishes, there has been little tendency to endemism in the Red Sea region, and only a single endemic species (from the Gulf of Aden, not from the Red Sea) is recorded here. Almost all the species dealt with here are widespread and, if the Dussumieriidae are any indication, such species can be expected to show very little variation between one region and another. Where, as is usually the case, my material shows no consistent variation from one part of the Red Sea region to another, then I have combined all measurements in a single description of the species.

DESCRIPTIONS, MEASUREMENTS, ETC.

All measurements were made with calipers and are not projected. The following measurements can be commented on.

a. *Standard length* : used throughout.
b. *Head length* : longest possible distance, i.e. not necessarily horizontal.
c. *Snout, eye and postorbital length* : measured along the same horizontal line (through eye centre) and thus *in toto* not equal to head length.
d. *Upper jaw length* : premaxillary symphysis to posterior maxilla tip.
e. *Abdominal scutes* : pre-pelvic counts include the pelvic scute itself, which is the most posterior scute with ascending arms lying in front of the pelvic

fins. The first post-pelvic scute lacks ascending arms and lies between the pelvic fin bases.

The following museum abbreviations have been used :—

H.U. Zoology Department, Hebrew University, Jerusalem (Israel South Red Sea Expedition and other material).
B.M.N.H. British Museum (Natural History).
S.F.R.S. Sea Fisheries Research Station, Haifa.
Z.M.C. Zoological Museum Copenhagen (Blegvad material).
N.M.V. Naturhistorisches Museum, Vienna (Steindachner material).
M.N.H.N. Museum Nationale d'Histoire Naturelle, Paris.
N.-M.F.-I.S. Natur-Museum und Forschungs-Institute, Senkenberg (Rüppell's material).

CLASSIFICATION AND NOMENCLATURE

The system of classification used here differs from that of Fowler (1956) and is based mainly on my own studies (Whitehead, 1963a and unpublished work). Similarly, I have been unable to accept certain of Fowler's names, either as a result of more recent work or of a more thorough examination of specimens and literature. The keys used here employ, where possible, external features suitable for field identification. Vernacular names are taken from Fowler (1956). Synonymies include reference to the original description and to all subsequent records from the Red Sea area (including the Gulf of Aden and the Persian Gulf). The spelling used for place names follows that of the author quoted, but in the section headed Range for each species, and in the map, I have followed the spelling of The Times Atlas (1959 edition).

Key to the Suborders and Families

A Lateral line present on body ; abdominal scutes always absent . Suborder **ELOPOIDEI**
1 Gular plate present ; 2 supramaxillae . . . . Superfamily ***Elopoidae***
a. Pseudobranch present ; last dorsal ray not filamentous
Family ***Elopidae*** (p. 231)
b. Pseudobranch absent ; last dorsal ray filamentous
Family ***Megalopidae*** (p. 232)
2 Gular plate reduced or absent ; 1 supramaxilla . Superfamily ***Albuloidae***
a. Dorsal fin short, about 15 rays . . . Family ***Albulidae*** (p. 232)
b. Dorsal fin long, 55–65 rays . . . Family ***Pterothrissidae*** (p. 233)

B Lateral line absent on body ; abdominal scutes often present Suborder **CLUPEOIDEI**
1 Dorsal much nearer to caudal base than to snout tip ; jaw teeth fang-like
Superfamily ***Chirocentroidae***
A single family, ***Chirocentridae*** (p. 233)
2 Dorsal origin near midpoint of body ; jaw teeth small or absent (very rarely fang-like) . . . . . Superfamily ***Clupeoidae***
a. Mouth terminal or subterminal, jaws short ; snout not tapering or pig-like.
i. No abdominal scutes, belly rounded . Family ***Dussumieriidae*** (p. 234)
ii. Abdominal scutes present, belly usually compressed, keeled
Family ***Clupeidae*** (p. 243)
b. Mouth inferior, jaws long ; snout tapering, pig-like
Family ***Engraulidae*** (p. 263)

Family **ELOPIDAE** (Tenpounders)

ELOPS Linnaeus, 1766

Elops Linnaeus, 1766, *Syst. Nat.*, ed. 12, **1** : 518 (Type : *Elops saurus*).
Argentina Forskål (*part.*), 1775, *Descript. Animal.* : xii, 68.

Revisions : Regan 1909, Bertin 1944a, Whitehead 1962a.

Elops machnata (Forskål)
(Machnat, Shag'oul)

Argentina machnata Forskål, 1775, *Descript. Animal.* : xii, 68 (Djidda).
Elops machnata : Rüppell, 1837,* *Neue Wirlbelth., Fische* : (80) 84 (Red Sea) ; Günther, 1866, *Fishes of Zanzibar* : 121, fig. (caudal) (Red Sea) ; Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116, fig. 2 (Red Sea) ; Bertin, 1944, *C.R. Soc. Biogeograph.* Paris, **21** : 2 (revision, all spp.) ; Fowler, 1956, *Fishes of Red Sea*, **1** : 56 (Indo-Pacific specimens) ; Whitehead, 1962, *Ann. Mag. nat. Hist.*, (13) **5** : 321 (Gulf of Aden).

Elops saurus : Valenciennes, 1846, *Hist. Nat. Poiss.*, **19** : (264) 365 (Red Sea ; Massaua) ; Günther, 1868, *Cat. Fish. Brit. Mus.*, **7** : 470 (Djidda) ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 603 (Red Sea) ; Boulenger, 1887, *Proc. zool. Soc. London* : 666 (Muscat) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 167 (S. Arabia).

*Dating follows Sawyer (1952).

Description : based on eight fishes, 110–167 mm. standard length from Sheikh Othman, Gulf of Aden (B.M.N.H. 1962.3.26.1–8).

In percentages of standard length : body depth 17·8–18·8, head length 26·5–29·5 ; snout length 6·1–6·8, eye diameter 6·2–6·9, post-orbital distance 14·7–16·2, upper jaw length 14·9–16·8, lower jaw 15·6–17·2, interorbital 4·3–4·8 ; gular plate, length 9·7–10·1, width 2·5–2·7 ; pectoral length 12·7–14·1, pelvic length 12·7–14·5 ; caudal peduncle, length 14·0–14·9, depth 8·5–9·0, length/depth ratio 1·55–1·70.

Dorsal vi 17–18, pelvic i 16, anal iii–v 11–13 ; scales in lateral series 94–97, scales round caudal peduncle 26 ; branchiostegal rays 29–32 ; vertebrae 63–64.

Colour : dorsal surfaces brown, sides silvery. Fins pale brown or colourless.

Size : 915 mm. (Fowler).

Range : Red Sea (Jiddah, Massawa), Gulf of Aden (Sheikh Othman), Gulf of Oman (Muscat), but apparently not from the Persian Gulf ; elsewhere, Zanzibar, coasts of India, ? S. Africa, East Indies, China, Japan, Hawaii.

E. machnata is distinguished from *E. hawaiensis* Regan by having fewer vertebrae (63–64 ; cf. 68–70) and a longer lower jaw ; and from *E. senegalensis* Regan by its fewer scales (83–97 ; cf. 92–100) (Whitehead 1962a). When further specimens are available, *E. hawaiensis* may prove only subspecifically distinct from *E. machnata*, and the same may be true of *E. senegalensis*. Prof. J. L. B. Smith has sent me a South African specimen which is intermediate between *E. senegalensis* and *E. machnata*.

Specimens:
8 fishes, 111–167 mm., Sheikh Othman, Gulf of Aden (B.M.N.H. 1962.3.26.1-8).

Family **MEGALOPIDAE** (Tarpons)

MEGALOPS Lacepède, 1803

Megalops Lacepède, 1803, *Hist. Nat. Poiss.*, **5** : 289 (Type : *Megalops filamentosus* Lacepède, =*Clupea cyprinoides* Broussonet).

Although *M. cyprinoides* occurs along the East African coast and along the Indian coasts, I can find no record of it in the Red Sea, the Persian Gulf or even in the Gulf of Aden.

Family **ALBULIDAE** (Lady fishes)

Two genera, one of which occurs in the Red Sea.

ALBULA Scopoli, 1777

(Bunnuch, Bunuk, Boenuk, Gasma, Boluk, Bonuk)

Albula Scopoli, 1777, *Introd. Hist. Nat.* : 450 (on Gronow) (Type : *Esox vulpes* Linnaeus).

A single species in all tropical seas.

Albula vulpes (Linnaeus)

Esox vulpes Linnaeus, 1758, *Syst. Nat.*, ed. 10, **1** : 313 (on *Bone Fish* Catesby, 1737, *Hist. Nat. Carolina*, pl. 2, fig. 1—Bahamas).

Albula vulpes : Tortonese, 1937, *Boll. Mus. Zool. Anat. Comp. Univ. Torino*, **45** (3), No. 63 : 12 (Red Sea) ; Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116, fig. 2 (Red Sea) ; *Idem*, 1956, *Fishes of the Red Sea*, **1** : 57 (Indo-Pacific and American specimens).

Argentina glossodonta Forskål, 1775, *Descript. Animal.* : xiii, 68 (Djidda ; Lohaja).

Butirinus glossodontus : Rüppell, 1837, *Neue Wirbelth., Fische* : 80, pl. 20, fig. 2 (Djidda) ; Günther, 1866, *Fishes of Zanzibar* : 120 (Red Sea).

Albula glossodonta ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 602 (Red Sea) ; Steinitz & Ben-Tuvia, 1955, *Bull. Sea Fish. Res. Sta., Haifa*. No. 11 : 4 (Gulf of Aqaba).

Argentina bonuk Lacepède, 1803, *Hist. Poiss. Nat.*, **5** : 366 (Arabian Sea).

Albula bananus : Valenciennes, 1846, *Hist. Nat. Poiss.*, **19** (249) 345 (Massaua).

Albula conorhynchus : Günther, 1868, *Cat. Fish. Brit. Mus.*, **7** : 468 (Red Sea).

Description : based on a single specimen 164 mm., standard length *ex* Aden.

In percentages of standard length : body depth 23·7, head length 28·7 ; snout length 11·3, eye diameter 5·9, interorbital 6·6, upper jaw length 10·5 ; pectoral length 14·7, pelvic length 12·7.

Dorsal iii 14, anal ii 6, pelvic i 9 ; 63 + 6 scales in lateral series ; gillrakers 10 + 1 + 10.

Size : 915 mm. (Fowler).

Range : Red Sea (Jiddah, Lohaja, Gulf of Aqaba, Massawa), Gulf of Aden (Aden), but not yet from Persian Gulf ; elsewhere, all tropical seas.

On the basis of published material, there seems to be no justification for separating the Red Sea *Albula* from *A. vulpes*, although a world revision with adequate material may demonstrate various subspecies.

Specimens :

1 fish, 164 mm., Aden (B.M.N.H. 1962.3.26 : 9).

1 fish, 374 mm., Red Sea (B.M.N.H. 1845.10.29.71) (stuffed).

1 fish, Gulf of Aqaba, coll. Bertram (H.U. 1699) (not seen).

Günther (1868) lists a half-grown fish, *ex*. Red Sea, but no specimen is labelled as such ; several bottles, however, have no locality data.

Family **PTEROTHRISSIDAE**

Not represented in Red Sea.

Family **CHIROCENTRIDAE** (Wolf Eels)

CHIROCENTRUS Cuvier, 1817

Chirocentrus Cuvier, 1817, *Règne Animal*, **2** : 178 (Type : *Clupea dorab* Forskål).

Fowler (1941) recognises two Indo-Pacific species, one of which occurs in the Red Sea.

Chirocentrus dorab (Forskål)

(Dorab, Lysan, Machnat, Aasa Macha, Abusef, Kharoo, Doheer)

Clupea dorab Forskål, 1775, *Descript. Animal.* : xii, 72 (Djidda ; Moccha).

Chirocentrus dorab : Rüppell, 1837, *Neue Wirbelth., Fische* : 81 (Red Sea) ; Valenciennes, 1846, *Hist. Nat., Poiss.*, **19** : (110) 150, pl. 565 (Massaua) ; Günther, 1866, *Fishes of Zanzibar* : 120 (Red Sea) ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 606 (Koseir, Red Sea) ; Boulenger, 1887, *Proc. zool. Soc. London* : 666 (Muscat) ; Meek, 1897, *Field Col. Mus. Publ.*, No. 22, *Zool. Ser.*, **1** (8) : 173 (Aden) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 167 (E. Arabia) ; Tortonese, 1937, *Boll. Mus. Zool. Anat. Comp. Un. Torino*, (3) **45**: 13 (Massaua) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 56, fig. 24 (Bushire Roads); Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116 (Red Sea) ; Ben-Tuvia and Steinitz, 1950, *Bull. Sea Fish. Res. Sta. Haifa*, No. 2 : 4 (Eilat) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 78 (Indo-Pacific specimens) ; Menon, 1960, *Rec. Indian Mus.*, **54** (3–4) : 141 (Persian Gulf).

Description : based on a single specimen 490 mm. standard length from Muscat ; meristic ranges from Fowler (1956).

In percentages of standard length : body depth 14·3, head length 17·4 ; snout length 4·6, eye diameter 3·8, upper jaw length 9·4 ; pectoral length 12·3, pelvic length 2·9 ; pre-dorsal distance 69·5, pre-pelvic distance 49·0, pre-anal distance 67·5.

Canine teeth in jaws. Body strongly compressed, dorsal and anal fins set well behind midpoint of body. Pectoral axillary scales well-developed, about three-quarters length of fin.

Dorsal iv 12–13, pelvic i 6, anal iv 30. No abdominal scutes, but a pair of crescentic pelvic scutes (see Whitehead 1963a). Scales small and caducous ; a scaly sheath at bases of dorsal and anal fins. Gillrakers 3 + 11.

Colour : in alcohol, upper surfaces dark blue or grey, lower surfaces yellow or silvery ; fins hyaline.

Size : 800 mm. (estimated from head length of specimen in Hebrew University) ; Fowler (1956) states " said to reach 12 feet ", but gives no authority for this.

Range : Red Sea (Jiddah, Mocha, Massawa, Quseir, Eilat), Gulf of Aden (Aden), Persian Gulf (Bushehr), Gulf of Oman (Muscat) ; elsewhere, Indian Ocean eastwards to Philippines, China, Australia, Melanesia.

Specimens :

1 fish, 490 mm., Muscat (B.M.N.H. 1887.11.11.321).

1 fish, head only, 139 mm. from premaxillary symphysis, (H.U. no number, no locality but almost certainly Red Sea).

Family **DUSSUMIERIIDAE** (Round herrings)

Fowler (1941, 1956) uses the name Stolephoridae, but this is incorrect (see Opinion 93, *Int. Comm. Zool. Nomenclature*, and Whitehead 1963b and c).

Revisions : Bertin 1943a, Whitehead 1963b.

Key to the Subfamilies

A Dorsal rays 16–21 ; branchiostegal rays 14–19 ; adults 150–220 mm.
Subfamily ***Dussumieriinae***

B Dorsal rays 11–16 ; branchiostegal rays 6–7 ; adults 50–110 mm.
Subfamily ***Spratelloidinae***

Subfamily Dussumieriinae

Two genera, both found in the Red Sea.

Key to the Genera

1 Pelvic fins under dorsal base ; two supramaxillae ; anal rays 14–19 . ***Dussumieria***
2 Pelvic fins behind dorsal base ; a single supramaxilla ; anal rays 9–13 ***Etrumeus***

DUSSUMIERIA Valenciennes, 1847

Dussumieria Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 467 (Type : *Dussumieria acuta* Valenciennes).

Montalbiana Bertin (misspelt), 1943, *Bull. Inst. océanogr. Monaco*, No. 853 : 7 (Type : *Etrumeus* (*Montalbania*) *albulina* Fowler).

Fowler (1956) recognised two Red Sea species, *D. productissima* Chabanaud as well as *D. acuta* Valenciennes. However, Red Sea specimens of *Dussumieria* closely resemble the Japanese form, and specimens from the Gulf of Aden are intermediate between *D. productissima* and *D. acuta* (Whitehead 1963b). I have therefore recognised only a single Red Sea species, the widespread *D. acuta*.

Dussumieria acuta Valenciennes

(Hashinch (Iran), Mooza, Sardin mabroun, Sardo, Sardin rachidi)

Dussumieria acuta Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 467, pl. 606 (Type locality : Bombay, Coromandel) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 157 (Gischin) 167 (S. Arabia) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 57, fig. 25 (Bushire Roads ; off Jabrin) ; Fowler and Steinitz, 1956, *Bull. Res. Council Israel*, **5** B (3–4) : 261 (Ascalon, E. Mediterranean) ; Fowler, 1956, *Fishes of Red Sea*, **1** : 62 (Indo-Pacific specimens) ; Whitehead, 1963, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **10** (6) : 312, figs. 1–5 (Gulf of Aden, Persian Gulf, Haifa).

Dussumieria hasseltii : Tillier, 1902, *Mém. Soc. zool. France*, **15** : 318 (Red Sea).

Dussumieria hasselti : Chabanaud, 1932, *Bull. Mus. Hist. nat. Paris*, (2) **4** (7) : 823 (L. Amer.).

Dussumieria productissima Chabanaud, 1933, *Bull. Inst. océanogr. Monaco*, No. 627 : 4, fig. 3 (tongue) and figs. pp. 4–6 (Gulf of Suez ; Lake Timsah) ; *Idem*, 1933, *Bull. Soc. zool. France*, **58** : 289 (Lake Timsah) ; *Idem*, 1934, *Bull. Mus. Hist. nat. Paris*, (2) **6** (1) : 157 (*idem*) ; Gruvel, 1936, *Mém. Inst. Egypte*, **29** : 153, fig. 25 (*idem*) ; Gruvel and Chabanaud, 1937, *loc. cit.*, **35** : 3 (Lake Timsah ; Lake Amer, Suez Canal) ; Fowler, 1941, *Bull. U.S. nat. Mus.*, No. 100 : 570 (copied) ; Bertin, 1943, *Bull. Inst. océanogr. Monaco*, No. 853 : 6, fig. p. 5 (type material) ; *Idem*, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **15** (6) : 390 (Suez Canal ; Gulf of Suez ; Lake Amer) ; Tortonese, 1947, *Hist. nat. Roma*, **2** : 4 (Suez Canal) ; *Idem*, 1948,

Arch. Zool. Ital., **33** : 276 (L. Timsah) ; Ben-Tuvia, 1953, *Bull. Sea Fish. Res. Sta., Haifa*, No. 8 : 6, fig. 1 (Haifa, Mediterranean) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 62 (compiled).

DESCRIPTION : based on one fish, 114 mm. standard length from the N. Massawa Channel ; eleven fishes, 105–148 mm., from the Gulf of Aden ; and twenty-five fishes, 64–114 mm., from Haifa. Mediterranean and Gulf of Aden fishes are included in this description because their similarity in morphometric and meristic characters argues that the intervening Red Sea population must also be similar. More Red Sea specimens might show this to be incorrect, however.

In percentages of standard length : body depth 19·3–23·0, head length 25·3–29·4 ; snout length 9·1–10·8, eye diameter 6·9–7·4 ; pre-dorsal distance 55·5–58·5, pre-pelvic distance 60·0–62·5, pre-anal distance 79·0–82·5.

Dorsal iv–v 14–16, pectoral i 12–13 (Haifa only), pelvic i 7, anal ii–iii 12–14 ; gillrakers 26–31 (Chabanaud 29–34) ; branchiostegal rays 14–16.

COLOUR : in alcohol, dorsal surfaces dark blue or dark brown, flanks white or silvery ; fins hyaline.

SIZE : 148 mm. (Gulf of Aden) ; maximum 216 mm. (Day).

RANGE : Eastern Mediterranean (Ben-Tuvia 1953), almost certainly as immigrants from the Red Sea ; Suez Canal, Lakes Timsah and Amer, Gulf of Suez (Chabanaud 1933, Gruvel and Chabanaud 1937) ; Red Sea (Massawa), Gulf of Aden (Mukalla, Shihr, Qishn), Persian Gulf (Jabrin, Bushehr) ; elsewhere, Indo-Pacific region from Natal to Japan.

Specimens :

1 fish, 115 mm., N. Massaua Channel at 27 fathoms (H.U. E57/694).

1 fish, 114 mm., N. Massaua Channel (H.U. E57/732).

5 fishes, 64–114 mm., Haifa, Israel (B.M.N.H. 1962.6.13.4–8).

20 fishes, 77–107 mm., Haifa, Israel (S.F.R.S.).

4 fishes, 102–122 mm., ' Mediterranean ' (H.U. A/16 inv. 2581).

5 fishes, 105–114 mm., Mukalla, Gulf of Aden (B.M.N.H. 1962.3.26.217–221).

6 fishes, 121–148 mm., Shihr & Burum, Gulf of Aden (B.M.N.H. 1962.3.26.211–216).

3 fishes, 89–110 mm., Persian Gulf (Blegvad) (Z.M.C. CN5–7).

NOTES ON MATERIAL EXAMINED : The three Persian Gulf specimens differ from the Red Sea fishes in having slightly deeper bodies (23·4–24·6% of S.L.), shorter snouts (8·2–8·9% of S.L.) and fewer gillrakers (22–24) ; in these characters they resemble Indian Ocean specimens (Whitehead 1963b, figs. 1–3). Chabanaud's (1933) high gillraker counts in Suez specimens are suggestive of a discrete Red Sea population. But the lower counts in Mediterranean specimens hint rather at Phenotypic variation correlated perhaps with temperature or salinity, since the Mediterranean population must have been derived from Red Sea fishes.

ETRUMEUS Bleeker, 1853

Etrumeus Bleeker, 1853, *Verh. Bat. Gen.*, **25** : 48 (Type : *Clupea micropus* Schlegel).

REVISIONS : Bertin 1943a, Whitehead 1963b.

A single, world-wide species chiefly occurring in temperate regions.

Etrumeus teres (De Kay)
(No local names known)

Alosa teres De Kay, 1842, *Nat. Hist. New York*, pt. 4, *Fishes* : 262, pl. 40, fig. 128 (Type locality : New York region).

Etrumeus teres : Whitehead, 1963, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **10** (6) : 321 (Eilat, Gulf of Aqaba ; Haifa, Mediterranean).

Etrumeus micropus : Fowler and Steinitz, 1956, *Bull. Res. Counc. Israel*, **5B** (3–4) : 261 (except 58 mm. specimen) (Eilat, Gulf of Aqaba).

Note on synonymy.

Although small meristic and proportional differences exist between the various isolated populations of *Etrumeus*, only the South African fishes can be clearly distinguished from the rest (one or two fewer dorsal rays—see Whitehead 1963b). The two Red Sea specimens examined more closely resemble the Japanese rather than the South African form.

DESCRIPTION : based on two fishes, 133–134 mm. standard length from Eilat ; and one fish, 165 mm. from Haifa (its measurements placed in parenthesis).

In percentages of standard length : body depth 16·4–17·1 (20·7), head length 23·7–24·1 (22·8) ; snout length 8·4–8·8 (7·4), eye diameter 8·0–8·2, upper jaw length 8·4 ; pre-dorsal distance 45·0–45·3, pre-pelvic distance 64·5–65·8, pre-anal distance 84·0.

Dorsal v 16 (v 16), pectoral i 15 (i 16), pelvic i 7, anal iii 8 (iii 8) ; gillrakers 32–34 (36). Scales caducous, about 50–56 in lateral series.

COLOUR : in alcohol, dorsal surfaces dark brown or blue, flanks light brown or silver ; fins hyaline.

SIZE : 165 mm. (Haifa) ; maximum 265 mm. (California).

RANGE : Eastern Mediterranean (almost certainly as immigrants from Red Sea), Red Sea (Gulf of Aqaba) ; elsewhere, South Africa ; southern coasts of Australia ; coasts of Japan ; Atlantic and Pacific coasts of North America ; Galapagos Islands.

Specimens :

2 fishes, 133–134 mm., Eilat, Gulf of Aqaba (S.F.R.S. A.339).

1 fish, 165 mm., Haifa, Israel (S.F.R.S. collection).

NOTE ON MATERIAL EXAMINED. The occurrence of *Etrumeus* in the Red Sea is very surprising in view of its distribution elsewhere in warm temperate regions. As in the case of *Dussumieria*, *Etrumeus* is absent from the Eastern Atlantic. It is therefore most likely that the Mediterranean specimen is an immigrant from the Red Sea. Since variation in morphometric and meristic characters between the other, widely distributed populations is slight, the resemblance between the Red Sea fishes and those from Japan is perhaps coincidental (Whitehead 1963b). The great difference in hydrological conditions between these two areas implies considerable morphological stability of the species.

Subfamily SPRATELLOIDINAE

Four Indo-Pacific genera, *Spratelloides*, *Ehirava*, *Gilchristella* and *Spratellomorpha*, of which only the first is represented in the Red Sea area.

SPRATELLOIDES Bleeker, 1851

Spratelloides Bleeker, 1851, *Natuurk. Tijdschr. Ned. Ind.*, **2** : 214 (Type : *Clupea argyrotaeniata* Bleeker = *Clupea gracilis* Schlegel).

Stolephorus : (*non* Lacepède) : Fowler, 1941, *Bull. U.S. nat. Mus.*, No. 100 : 561.

Some authors have followed Fowler in using *Stolephorus* for this genus, but this is incorrect (see Gosline 1951, Whitehead 1963c).

Two species, both found in the Red Sea.

Key to the Species

a A bright and prominent silver midlateral line ; total anal rays 11–14 ; scales in lateral series 41–49 . . . . . ***Spratelloides gracilis***

b No silver band, but whole flank silver ; total anal rays 9–11 ; scales in lateral series 32–46 . . . . . ***Spratelloides delicatulus***

Spratelloides gracilis (Schlegel)
(Seil)

Clupea gracilis Schlegel, 1846, *Faun. Japon. Poiss.*, pts. 10–14 : 238, pl. 108, fig. 2 (Type locality: Southeast coasts of Nagasaki).

Spratelloides gracilis : Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 601 (Red Sea) ; Chabanaud, 1932, *Bull. Mus. Hist. nat. Paris*, (2) **4** (No. 7) : 824 (Lac Amer, Suez Canal) ; Gruvel and Chabanaud, 1937, *Mém. Inst. Egypte*, **35** : 4 (Suez Canal) ; Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **15** (No. 6) : 390 (Gulf of Suez) ; Whitehead, 1963, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **10** (6) : 338, figs. 15–18 (Ghardaqa, Senafir).

Spatelloides (error) *gracilis* : Borsieri, 1904, *Ann. Mus. Civ. Stor. nat. Genova*, (3) **1** : 218 (Nocra, Daalac I., Red Sea).

Stolephorus gracilis : Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116 (Red Sea).

Spratelloides japonicus : Marshall, 1952, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **1** : 22 (Ghardaqa, Senafir).

Description : based on twenty-five fishes, 43·8–54·0 mm., from Eilat, Gulf of Aqaba ; four fishes, 36·0–37·8 mm., from Sinafir, Gulf of Aqaba ; and two fishes, 46·5–48·8 mm., from Ghardaqah.

In percentages of standard length : body depth 13·4–16·8, head length 22·7–24·6 ; snout length 7·2–8·4, eye diameter 5·5–6·6, upper jaw length (from tip of snout) 8·0–9·8 ; pectoral length 10·4–12·1, pelvic length 9·2–10·6 ; pre-dorsal distance 46·4–49·5, pre-pelvic distance 52·0–57·8 ; pre-anal distance (75·2) 79·3–84·0.

Posterior supra-maxilla with upper border rising steeply anteriorly, general shape of expanded portion of this bone as in Figure 2b (see below). Posterior frontal fontanelles divided by wedge of bone anteriorly (Figure 3b) (see below).

Dorsal ii (9) 10, pectoral i 11–12, pelvic i 7, anal (11) 12 of which ii or iii are simple rays. Scales caducous, about 40–50 in lateral series, and 8–9 in transverse series.

Colour : in life, upper surfaces pale transparent green with median dorsal line of dark chromatophores ; flank with intense silver band as wide as eye diameter from gill-opening to caudal base, edged above and below by fine irridescent blue line. Lower flank almost transparent, with silver peritoneum visible. Pupil black, iris silver, a small black dot just behind eye. Rest of head silver, with scattered melanophores on tip of lower jaw and snout. A very prominent black mark just above the anterior supra-maxilla. Fins colourless, but black markings at bases of outer caudal rays and along posterior border of caudal peduncle.

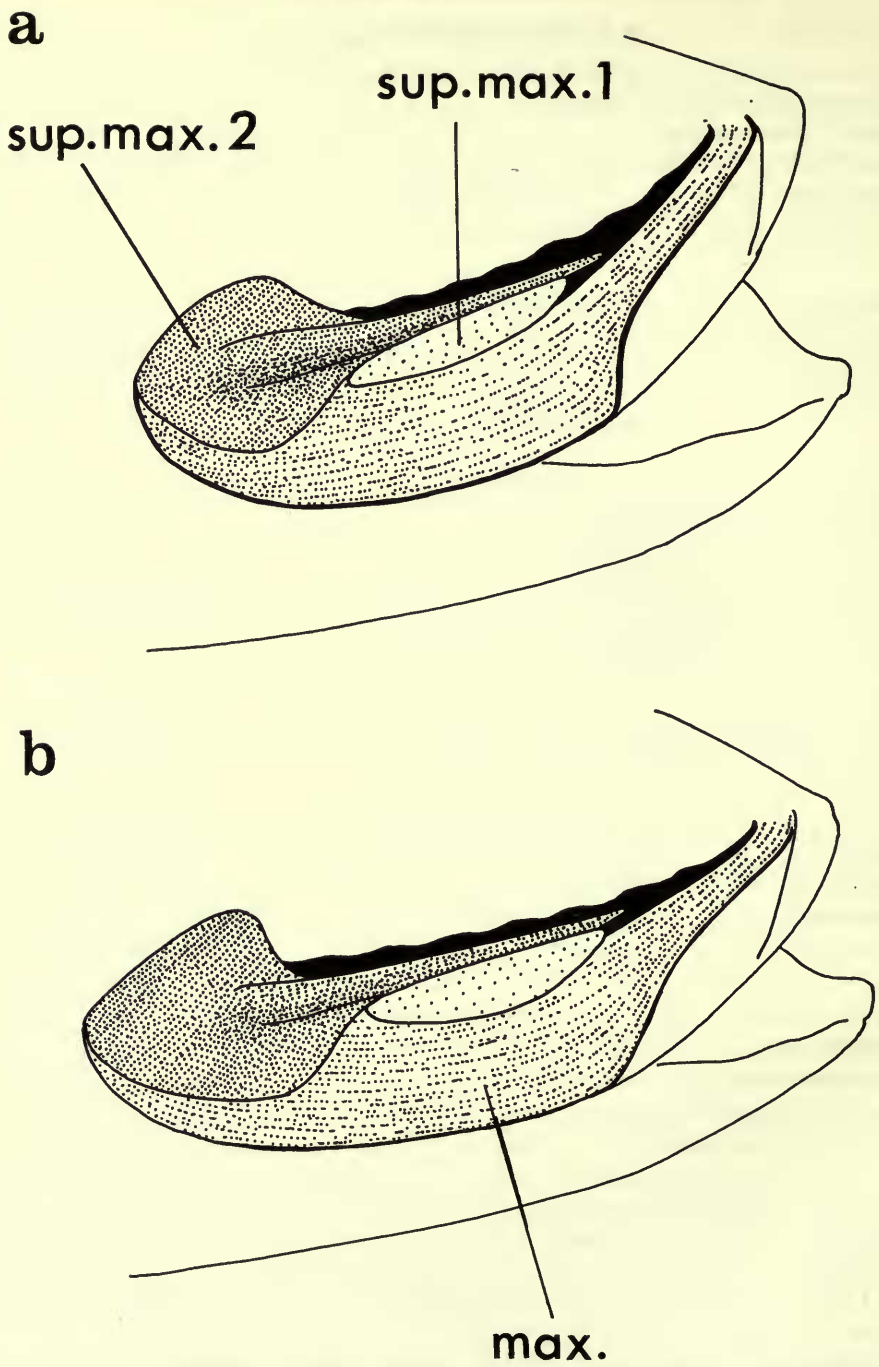

FIG. 2. Maxillary bones in species of *Spratelloides*. a. *S. delicatulus* (42 mm., Red Sea). b. *S. gracilis* (48 mm., Red Sea).
*sup.max.*1 —1st or anterior supra-maxilla. *sup.max.*2 —2nd or posterior supra-maxilla. *max.*—maxilla.

After fixation, silver stripe fades to brown or black, with rest of body light brown, head silver ; all black markings retained.

SIZE : largest specimen examined, 54 mm. S.L. (Japanese specimens up to 93 mm. recorded—Whitehead 1963b, p. 375.)

RANGE : Suez Canal (Lac Amer), Red Sea (Gulf of Suez, Gulf of Aqaba, Sharm el Sheikh, Al Ghardaqah, Sinafir I., Nocra, Dahlak I.), but no records from the Gulf of Aden, Persian Gulf or Gulf of Oman ; elsewhere, widespread in Indo-Pacific region, from East Africa to Japan and Samoa.

Specimens:

2 fishes, 45–47 mm., Ghardaqa, Red Sea (B.M.N.H. 1935.9.30.10–11).
Many fishes, 15–54 mm., Eilat (B.M.N.H. 1963.10.19.51–100).
Many fishes, post-larvae to 37 mm., Sinafir (B.M.N.H. 1951.1.16.36–60).
2 fishes, 12 mm., Eilat (H.U. E55/485, 1).
3 fishes, 18–21 mm., Sharam a Sheikh (H.U. E57/330).
17 fishes, 15–21 mm., Sharam a Sheikh (H.U. E57/329).
Many fishes, 13–15 mm., Eilat (H.U. E56/1).
Many fishes, 13–14 mm., Eilat (H.U. E56/403, 13).
Many fishes, 9–13 mm., Eilat (H.U. E56/403, 11).
15 fishes, 15–19 mm., Sharam a Sheikh (H.U. E57/290).
34 fishes, 10–11 mm., Eilat (H.U. E55/362).
4 fishes, 37–54 mm., Eilat (H.U. E58/303).
5 fishes, 11–17 mm., Eilat (H.U. E58/158, 3).
2 fishes, 17 mm., Eilat (H.U. 2069).
Many fishes, 14–21 mm., Eilat (H.U. E56/403, 14).
6 fishes, 17–21 mm., Sharam a Sheikh (H.U. E57/287).
71 fishes, 16–27 mm., Eilat (H.U. E58/272).
1 fish, 37 mm., Eilat (H.U. E57/678, 1).
1 fish, 29 mm., Eilat (H.U. E58/157d).
51 fishes, 24–29 mm., Eilat (H.U. E49/121).
41 fishes, 25–29 mm., Eilat (H.U. E58/272, 3).
3 fishes, 23–35 mm., Sharam a Sheikh (H.U. E57/325).
3 fishes, 44–46 mm., Eilat (H.U. E60/90, 3).
Many fishes, 18–22 mm., Sharam a Sheikh (S.F.R.S. collection).

NOTES ON MATERIAL EXAMINED. Adults of the two species of *Spratelloides* can be fairly readily separated on colouration and anal finray count. But the Hebrew University collections contain a large number of small juveniles and post-larvae whose identity is difficult to determine. There are, however, three further characters separating the two species which can be applied to fishes of over 20–25 mm.

a. Shape of second (posterior) supra-maxilla. In *Spratelloides* there are two supra-maxillae, the posterior one being paddle-shaped with a slender anterior shaft. In *S. delicatulus*, the expanded portion of the 2nd supra-maxilla is almost circular, the upper and lower profiles meeting the anterior shaft almost opposite one another. (Figure 2a). In *S. gracilis*, the expanded portion is more oblate, the upper border

rises more steeply anteriorly, and the lower profile meets the anterior shaft in front of the point at which the upper border meets it (Figure 2b). This difference in shape also distinguishes the genus *Sardinella* (*delicatulus* shape) from *Herklotsichthys* (*gracilis* shape) (see p. 244).

b. Posterior frontal fontanelles. In *Spratelloides* (but not in *Dussumieria* or *Etrumeus*), a pair of fontanelles on the posterior dorsal part of the head is retained in adults ; the fontanelles are divided in the midline by an anterior extension of the supra-occipital. In *S. gracilis* the fontanelles are longer than in *S. delicatulus*, measuring 1·5–1·8 mm. in fishes over 20 mm. (0·85–1·4 mm. in *S. delicatulus*). A further difference occurs in the shape of the fontanelles (Figure 3a and b). In *S. gracilis* the fontanelles are rather broadly divided anteriorly by a wedge of bone, whereas in *S. delicatulus* they are narrowly divided. This difference also distinguishes the two West Indian species of *Jenkinsia*.

c. Caudal colouration. In both species there are two black markings above and below the midline at the bases of the caudal rays. In *S. delicatulus* these appear as discrete lines of pigment joined at their bases to form a U, whereas in *S. gracilis* they are more diffuse.

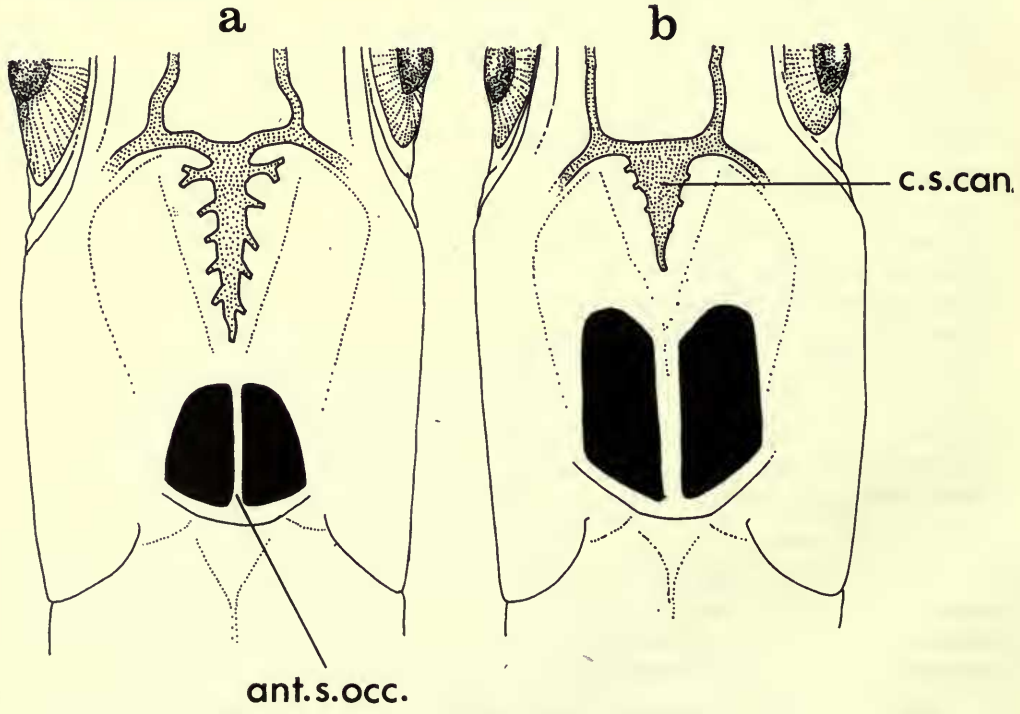

FIG. 3. Dorsal view of posterior part of head showing posterior frontal fontanelle shape (in black) in species of *Spratelloides*. a. *S. delicatulus* (42 mm., Red Sea). b. *S. gracilis* (41 mm., Red Sea).

ant. s. occ.—anterior extension of supra-occipital. *c. s. can.*—cutaneous sensory canal, a posterior extension from the transverse frontal canal.

Spratelloides delicatulus (Bennett)

Clupea delicatula Bennett, 1831, *Proc. zool. Soc. London*, **1** : 168 (type locality Mauritius).
Spratelloides delicatulus : Marshall, 1952, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **1** : 222 (Gulf of Aqaba) ; Fowler and Steinitz, 1956, *Bull. Res. Counc. Israel*, **5** B (3–4) : 262 (Eilat) ; Whitehead, 1963, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **10** (6) : 345 (Red Sea, Gulf of Aden).
Etrumeus micropus : Fowler and Steinitz, 1956, *Bull. Res. Counc. Israel*, **5** B (3–4) : 261 (Eilat) (misidentification of 58 mm. specimen).

Description : based on twenty specimens, 38·5–48·5 mm., from Eilat, Gulf of Aqaba ; twelve fishes, 39·1–44·6 mm., from Sinafir ; and three fishes, 38–42 mm., from Marsa Halaib.

In percentages of standard length : body depth 18·4–20·4 , head length 24·2–26·0; snout length 6·4–7·3, eye diameter 6·9–7·9, upper jaw length (from snout tip) 8·9–9·4 ; pectoral length 14·2–15·0, pelvic length 11·8–12·7 ; pre-dorsal distance 45·4–48·5, pre-pelvic distance 53·5–56·0.

Dorsal ii 9–11, pectoral i 10–11, pelvic i 7, anal 9–11 (of which ii or iii are unbranched). Scales caducous, about 32–46 in lateral series, and 7–9 in transverse series.

Posterior supra-maxilla with rounded expanded portion, as in Figure 2a. Posterior frontal fontanelles shorter than in *S. gracilis* and only narrowly divided anteriorly (Figure 3a).

Colour : In life, upper surfaces light, vivid blue with dark blue mottling, flanks silver, belly white. Pupil black, iris silver, some small black dots on upper part of operculum. Dorsal part of head dark blue, remainder silver, but tips of snout and lower jaw with dark pigmentation ; a prominent black mark just above anterior supra-maxilla. Fins colourless, but two distinct black lines at base of caudal fin just above and below midline and scattered melanophores along upper border of caudal peduncle.

After fixation, upper surfaces dark brown or black, silver of flanks fading to white ; all black markings retained.

Size : largest Red Sea specimen examined, 50 mm. (Australian specimens up to 77 mm.—Whitehead 1963b, p. 376.)

Range : Red Sea (Eilat, Sinafir I., Marsa Halaib, Derom I., Nocra, Kad Eidwid reefs), Gulf of Aden, but not from Persian Gulf or Gulf of Oman ; elsewhere, widespread in Indo-Pacific region, from East African coast to Australia (but not to Japan).

Specimens:
10 fishes, 21–49 mm., Firaun I. (B.M.N.H. 1951.1.16.14–23).
12 fishes, 39–47 mm., Senafir I. (B.M.N.H. 1951.1.16.24–35).
16 fishes, 16–45 mm., Marsa Halaib (B.M.N.H. 1960.3.15.16–31).
8 fishes, 36–39 mm., Kad Eidwid reefs (B.M.N.H. 1960.3.15.33–39).
16 fishes, 39–42 mm., Gulf of Aden (B.M.N.H. 1962.6.19.1–16).
1 fish, 40 mm., (alizarin) Marsa Halaib (B.M.N.H. 1960.3.15.32).
Many fishes, 20–30 mm., Eilat (B.M.N.H. 1963.10.19.1–50).

1 fish, 49 mm., Eilat (S.F.R.S. A42/a 1949).
37 fishes, 35–47 mm., Eilat (H.U. E56/408).
37 fishes, 41–49 mm., Eilat (H.U. E?/227).
2 fishes, 42–48 mm., Eilat (H.U. E56/404).
3 fishes, 37–42 mm., Eilat (H.U. E60/70).
35 fishes, 19–42 mm., Derom I. (H.U. E57/770, 3).
8 fishes, 37–48 mm., Eilat (H.U. E56/405).
1 fish, 39 mm., Eilat (H.U. E55/839).
2 fishes, 36–48 mm., Eilat (H.U. E59/176, 1).
3 fishes, 24–47 mm., Eilat (H.U. E58/157d).
2 fishes, 39–47 mm., Eilat (H.U. E58/272, 2).
1 fish, 50 mm., Eilat (H.U. E57/678, 1).
1 fish, 29 mm., no data (H.U. E62/3316).
6 fishes, 35–43 mm., Nocra I. (H.U. E62/587).
11 fishes, 23–36 mm., no data (H.U. E62/3335).
Many fishes, 18–44 mm., no data (H.U. E62/3322).
1 fish, 18 mm., Eilat (H.U. E55/364).
11 fishes, 19–23 mm., Eilat (H.U. E55/524a).

Note on material examined. Where one or two juveniles under 20 mm. occur in a sample of larger fishes, the identity of the juveniles has been presumed to be the same as the larger fishes. In many samples, however, this could not be done, and these are recorded below as *Spratelloides* sp.

In most of the genera of the Dussumieriidae there is only a single abdominal scute, the pelvic scute. In *Spratelloides* the pelvic scute is W-shaped, the arms encircling the bases of the anterior pelvic rays. The pelvic scute was clearly visible in a fish of 21·7 mm., and just visible at 17·5 mm. This ruled out the possibility that the smaller fishes were juvenile clupeids, since the latter have lateral ascending arms on the pelvic scute, and also the pelvic scute (at least in the Pellonulinae) develops after the other abdominal scutes, according to Poll (1964).

Specimens (*Spratelloides* sp. juveniles):
10 fishes, 19–24 mm., Eilat (H.U. E58/158, 4).
1 fish, 21 mm., Eilat (H.U. E55/524f).
1 fish, 17 mm., Eilat (H.U. E55/524g).
19 fishes, 10–18 mm., Eilat (H.U. E57/678, 7).
1 fish, 22 mm., Eilat (H.U. E55/524b).
4 fishes, 20–29 mm., Sharam a Sheikh (H.U. E57/326).
19 fishes, 16–22 mm., Derom I. (H.U. E57/7702).
10 fishes, 14–22 mm., Eilat (H.U. E59/176, 5).
31 fishes, 14–20 mm., Eilat (H.U. E58/268, 1).
2 fishes, 14–15 mm., ? Massawa (H.U. E57/680, 2).
25 fishes, 11–19 mm., Eilat (H.U. E58/272, 5).
7 fishes, 14–17 mm., Derom I. (H.U. E57/770, 1).
10 fishes, 10–16 mm., Khoz Seguri, S. Red Sea (H.U. E61/14, 2.1).

Family **CLUPEIDAE** (Herrings)

Seven genera, representing four of the five subfamilies of the Clupeidae, are found in the Red Sea.

Key to the Genera

A Mouth terminal, sometimes superior ; stomach generally not gizzard-like.
- 1 Anal fin moderate, 15–25 rays ; pelvic fins present.
  - a. Upper jaw without median notch (Clupeinae)
    - i. Fronto-parietal striae few (3–7) ; last two anal rays not enlarged ***Herklotsichthys***
    - ii. Fronto-parietal striae many (7–14) ; last two anal rays enlarged ***Sardinella***
  - b. Upper jaw with median notch (Alosinae); a single genus . . ***Hilsa***
- 2 Anal fin long, more than 30 rays ; lower jaw prominent ; pelvic fins absent or very small. (Pristigasterinae.)
  - a. Pelvic fins absent ; anal with 50–63 branched rays . . ***Opisthopterus***
  - b. Pelvic fins present ; anal with 34–36 branched rays . . . ***Ilisha***

B Mouth inferior, dentary reflected outwards ; stomach gizzard-like (Dorosomatinae)
- 1 Last dorsal ray filamentous . . . . . ***Nematalosa***
- 2 Last dorsal ray not filamentous . . . . . ***Anodontostoma***

Subfamily Clupeinae

HERKLOTSICHTHYS Whitley, 1951

Herklotsella Fowler, 1934, *Proc. Acad. nat. Sci. Philad.*, **85**: 246 (Type : *Harengula dispilonotus* Bleeker) (*non Herklotsella* Herre 1933, a siluroid genus).

Herklotsichthys Whitley, 1951, *Proc. Roy. zool. Soc. N.S.W.*, 1949–50 : 67 (proposed to replace *Herklotsella* Fowler 1934).

Harengula Valenciennes (*part.* i.e. Indo-Pacific species only), 1847, *Hist. Nat. Poiss.*, **20** : 201 (Type : *Harengula latulus* Valenciennes = *Clupea macropthalma* Ranzani, designated by Gill, 1861, *Proc. Acad. nat. Sci. Philad.*, : 36).

The Indo-Pacific species formerly placed in *Harengula* (e.g. by Fowler 1941) differ from the Western Atlantic species in lacking a small toothed hypo-maxillary bone lying between the tip of the pre-maxilla and the maxilla (Berry, in press). As I have shown elsewhere (Whitehead 1964a), *Clupalosa* Bleeker, *Paralosa* Bleeker and *Wilkesina* Fowler were based on species of *Sardinella*, while *Herklotsella* Fowler is pre-occupied by *Herklotsella* Herre.

The genus *Herklotsichthys* is badly in need of revision. As in *Sardinella*, species are chiefly separated on slight differences in body depth and numbers of gillrakers, both of which, at least in some cases, vary with the size of the individual. Some intraspecific variation in meristic counts may also be correlated with environmental factors or even, as in the case of *Dussumieria* (Whitehead 1963b), show a general increase (or decrease) towards the eastern and western limits of the Indo-Pacific region.

Herklotsichthys closely resembles *Sardinella*, but in addition to the two characters shown in the key above, the two genera can also be separated on the shape of the

second (posterior) supramaxilla. In *Herklotsichthys* the lower part of the expanded portion of this bone is larger than the upper part as in *Spratelloides gracilis* (Figure 2b). In *Sardinella*, the upper and lower lobes are about equal in size, the bone being more paddle-shaped, as in *Spratelloides delicatulus* (Figure 2a). However, in *H. vittata* the shape is nearer to the *Sardinella* type although still referable to the *Herklotsichthys* shape.

KEY TO THE SPECIES OF HERKLOTSICHTHYS

1 Gillrakers on lower part of first arch 29–38 ; caudal and dorsal tips colourless or faintly dusky ; dorsal and pectoral usually with 14–15 branched rays ***H. punctatus***

2 Gillrakers on lower part of first arch 45–57 ; caudal and dorsal tips black or dark grey ; dorsal and pectoral usually with 12–13 branched rays . . ***H. vittatus***

In *H. punctatus* the eye is larger than in *H. vittatus* (8·1–10·3% of S.L. in my material ; *cf.* 7·0–7·7) ; the upper jaw is longer (12·4–15·6 ; *cf.* 9·6–10·8) ; the post-orbital distance shorter (8·6–10·7 ; *cf.* 10·6–11·5) ; and the pectoral and pelvic fins are longer (18·2–21·5 and 12·2–15·0 ; *cf.* 17·0–20·5 and 10·2–11·7).

Herklotsichthys punctatus (Rüppell)

Clupea punctata Rüppell, 1837, *Neue Wirbelth., Fische* : 78, pl. 21, fig. 2 (Red Sea).

Harengula punctata : Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : (215) 297 (Massaua) ; Tillier, 1902, *Mém. Soc. zool. France*, **15** : 297 (Suez Canal) ; Norman, 1927, *Trans. zool. Soc. London*, **22** (3) : 378 (Lake Timsah ; Great Bitter Lake ; Suez Canal) ; Chabanaud, 1932, *Bull. Mus. Hist. nat. Paris*, (2) **4** (7) : 823 (L. Amer) ; *Idem*, 1936, *Mém. Inst. Egypte*, **29** : 153 (Suez Canal) ; Gruvel and Chabanaud, 1937, *loc. cit.*, **35** : 3 (Suez Canal) ; Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **5** (6) : 389 (Southern Suez Canal ; Lac Amer) ; Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116 (Red Sea).

Alosa punctata : Günther, 1866, *Fishes of Zanzibar* : 123 (Aden ; Red Sea).

Clupea quadrimaculata Rüppell, 1837, *Neue Wirbelth., Fische* : 78, pl. 21, fig. 3 (Bay of Massaua) ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 601 (Red Sea) ; Tillier, 1902, *Mém. zool. Soc. France*, **15** : 297 (Lac Amer ; Lake Timsah) ; Borsieri, 1904, *Ann. Mus. Civ. Storia nat. Genova*, (3) **1** : 217 (Massaua ; Dissei ; Daalac I.).

Harengula bipunctata Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : (216) 298 (Massaua).

Clupea bipunctata Ehrenberg, in Valenciennes (*loc. cit.*) (name in synonymy).

Harengula arabica Valenciennes, 1847, *op. cit.* : (217) 298 (Mohila).

Clupea arabica Ehrenberg, in Valenciennes (*loc. cit.*) (name in synonymy).

? *Clupea venenosa* : Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 599 (Red Sea) ; Boulenger, 1887, *Proc. zool. Soc. London* : 666 (Muscat) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 157 (Gischin ; Bal Haf ; Ras Schoab, Socotra), p. 167 (S. Arabia).

Clupea mollucensis : Bamber, 1915, *J. Linn. Soc. London*, **31** (Zool.) : 478 (Sudanese Red Sea).

Harengula ovalis : Tortonese, 1947, *Hist. Nat. Roma*, **2** : 4 (Suez Canal) ; Fowler, 1956, *Fishes of the Red Sea* : 64 (on Indo-Pacific specimens).

Sardinella melanura : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 66 (Bender Shahpur ; Bushire) ; Fowler ,1956, *Fishes of the Red Sea*, **1** : 67 (on Blegvad).

Note on synonymy.

Some authors have followed Fowler (1941) in identifying *Clupea ovalis* Bennett with this species. However, it seems unlikely that Bennett (1830) would have chosen this relatively slender species to describe as " *Clup. corpori ovali* " ; *Clupea ovalis* might refer to a species of *Sardinella* (depth 2·8–3·0 times in standard length

in *S. bulan*) ; or, in view of the low anal count and black humeral spot described by Bennett, *Hilsa kelee* seems possible. Bennett's description is poor, and the name should perhaps be considered a *nomen dubium*.

Three of Rüppell's paratypes of *Clupea quadrimaculata* which I have examined are clearly *H. punctatus* (gillrakers 34, 36, 36). Valenciennes (1847) based *Harengula bipunctata* on Ehrenberg's notes on " *Clupea bipunctata* ", and similarly, *H. arabica* on " *Clupea arabica* " of Ehrenberg. The descriptions are inadequate, and Valenciennes believed the first species at least to be very close to *H. punctatus*. I have followed Fowler (1956) in placing both these species (but tentatively) in the synonymy of *H. punctatus*. Boulenger's (1887) specimen of *Clupea venenosa* from Muscat belongs in this species, and from the descriptions given, *Clupea venenosa* of Klunzinger is also *H. punctatus*. *Clupea mollucensis* of Bamber has no description, but *Harengula mollucensis* Bleeker 1853 is almost certainly a synonym of *H. punctatus*. (The single Bleeker specimen of *H. mollucensis* in this museum, while probably not the holotype, as was supposed by Günther (1868), is *H. punctatus*). I have been able to examine seven specimens of " *Clupea venenosa* " collected by Steindachner from the Gulf of Aden and the Red Sea (see list of specimens studied). All these fishes are *H. punctatus*.

Bertin (1943b) believed that *H. punctatus* had already penetrated to the Mediterranean, basing this on the single record of *Clupea venulosa* Steinitz from the coast of Israel (Steinitz 1927). I have been able to examine this specimen, which is in the collections of the Zoologiczne Museum at Wroclaw (Poland), and it is *Sardinella aurita*. Although part of the collection at Wroclaw suffered damage during the war, Dr. Kozikowska informs me (*in. litt.*) that both the locality and the name labels for this specimen are in the handwriting of Dr. Steinitz.

Description : based on the holotype (58·5 mm.) and two paratypes of *Clupea punctata* Rüppell, 58–61 mm., from the Red Sea ; three paratypes of *Clupea quadrimaculata* Rüppell, 57–82 mm., from the Bay of Massawa ; nine fishes, 63–72 mm., from Eilat ; two fishes, 93–96 mm., from Eilat ; fifteen fishes, 63–73 mm., from Harmil I. (S. Red Sea) ; and four fishes, 82–86 mm., from Candala, Gulf of Aden. Additional head and body depth measurements and scute and gillraker counts made on eight further specimens from the Red Sea (see list of specimens).

In percentages of standard length : body depth 22·8–32·0, head length 25·6–31·4 ; snout length 7·4–8·8, eye diameter 8·1–10·3, upper jaw length 12·4–14·7(15·6), post-orbital distance 8·6–10·7 ; pectoral length 18·2–21·5, pelvic length 12·2–15·0 ; pre-dorsal distance 43·2–49·4, pre-pelvic distance 52·0–58·3, pre-anal distance (74·5)76·2–83·5.

Dorsal iv 14–15, pectoral i 14–15 (16), pelvic i 7, anal ii–iii 13–16 (total (16) 17–19). Abdominal scutes, pre-pelvic 17–18, post-pelvic 11–13 (14), total 28–31 (32). Scales fairly caducous, about 40–45 in lateral series, 10–11 in transverse series. Gillrakers on lower part of first arch 29–38.

	Gillrakers										
	29	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*Mean*
Red Sea . .				2	1	7	13	11	2	1	35·08
Gulf of Aden .			1		1	2					33·00
Persian Gulf .	1		1			1	1				32·25

Branchiostegal rays 6–7.

Colour : in alcohol, dorsal surfaces dark grey-blue or brown, flanks silvery or light brown; a series of small black dots on back from dorsal to caudal.

Size : 96 mm. (Eilat) ; to 153 mm. (Fowler 1956).

Range : Suez Canal (Lakes Timsah and Amer), Red Sea (Eilat, Massawa, Farasan I., Kameran, Suez, Suakim, Quseir, Mersa Haleib, Hassani, Dahlak I., Khoz Seguri, Harmil I., Dissei), Gulf of Aden (Aden, Kandala, Bal Haf, Ras Shoab, Qishn, Socotra), Persian Gulf (Bandar e Shahpur, Bushehr), Gulf of Oman (Muscat); elsewhere, widespread in Indo-Pacific region, from East Africa to Japan, Australia, Polynesia.

Specimens:

1 fish, 58·5 mm., Red Sea, Holotype of *Clupea punctata* Rüppell (N.-M.F.-I.S. 567).
2 fishes, 58–61 mm., Red Sea, Paratypes *Clupea punctata* Rüppell (N.-M.F.-I.S. 6649–50).
3 fishes, 57–82 mm., Bay of Massawa, Paratypes *Clupea quadrimaculata* Rüppell (N.-M.F.-I.S. 4648, 4649, 4651).
4 fishes, 82–86 mm., Eritrea (S.F.R.S. BT699).
1 fish, 68 mm., Khoz Seguri (S.F.R.S. BT676).
19 fishes, 54–71 mm., Massawa (H.U. E56/406).
1 fish, 81 mm., Eilat (H.U. E53/6).
19 fishes, 61–74 mm., Harmil I. (H.U. E62/3327).
2 fishes, 93–96 mm., Eilat (H.U. E56/405).
9 fishes, 63–72 mm., Eilat (H.U. E54/17).
2 fishes, 76–87 mm., Sudan, Red Sea (B.M.N.H. 1963.11.12.2).
1 fish, 89 mm., Muscat (Boulenger's *Clupea venenosa*) (B.M.N.H. 1887.11.11.317).
2 fishes, 67–73 mm., Red Sea, coll. Klunzinger (B.M.N.H. 1871.7.15.27).
4 fishes, 63–77 mm., Persian Gulf (Blegvad's *Sardinella melanura*) (Z.M.C. CN 1–4).
12 fishes, 75–104 mm., Gischin and Red Sea (Hassani, Mersa Haleib, Kosseir, Suakim, Suez, Cameran), Steindachner's *C. venenosa* (N.M.V. 1658, 1663, 1671, 1678, 1681, 1692, 1698).
40 fishes, 45–58 mm., Farasan I., Sarad Sarso, coll. Klausewitz (N.-M.F.-I.S. 4647).
6 fishes, 56–65 mm., Makauwa, Red Sea, coll. Klausewitz (N.-M.F.-I.S. no number).
39 fishes, 61–76 mm., Harmil I. (H.U. E62/3293).
52 fishes, 57–66 mm., Harmil I. (H.U. E62/3294).
19 fishes, 70–74 mm., Goliath Bay (H.U. E62/3252).

Herklotsichthys vittatus (Valenciennes)

Clupeonia vittata Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 352 (Type locality : Vanikoro).
Clupea kowal : Rüppell, 1837, *Neue Wirbelth., Fische* : 79 (Djidda, Massaua) ; ? Giglioli, 1888, *Ann. Mus. Civ. Stor. nat. Genova*, (6) **2** : 72 (Assab).
? *Harengula kowal* : Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116 (? on Rüppell).
? *Kowala coval*: Tortonese, 1947, *Boll. Soc. Adriat. Sci. nat. Trieste*, **43** : 82 (? on Rüppell).

Note on synonymy.

Records of *Kowala* from the Red Sea area seem to have originated from Rüppell's misidentification. Rüppell's specimen has eight pelvic rays (seven in *Kowala*) and a bilobed dermal outgrowth on the vertical portion of the cleithrum (absent in *Kowala:* see Whitehead, 1964c). In meristic and proportional characters, Rüppell's specimen agrees with *H. vittatus*. *Harengula kowal* of Fowler (1945) and *Kowala coval* of Tortonese (1947) are cited without descriptions and were probably based on Rüppell's record, as also *Clupea kowal* of Giglioli (1888).

Günther (1868) included *C. kowal* Rüppell in his synonymy of *Clupea kowal*, but all Günther's specimens (of which Bleeker's type of *Clupalosa bulan* is one) are *Sardinella bulan*. One of these specimens is the Zanzibar *Alosa kowal* of Günther (1866). Three further specimens, not included in the Catalogue but evidently identified by Günther as *Clupea kowal*, are in fact *S. bulan*.

Steinitz (1927) recorded " *Clupea kowal* Günther (*nec* Klunzinger) " from Haifa, Israel. Bertin (1943b) acknowledged this to be an immigrant from the Red Sea but identified Steinitz's specimen with *Sardinella gibbosa* (i.e. *S. jussieu*). I have examined a specimen, now in the collections of the Zoologiczne Museum at Wroclaw in Poland, which is believed to be that described by Steinitz ; it is in fact *Clupea harengus* L. Although the present specimen is the correct length (121 mm. S.L.), the body is too slender to fit Steinitz's description (4·85 times in length ; cf. 3·6 times) and there are fewer anal rays (iii 14 ; cf. 19). From the description, it is not possible to identify Steinitz's *C. kowal* with certainty.

A further reference to *Clupea kowal* is that of Klunzinger (1871). It was not collected by Klunzinger from the Red Sea and the description may have been based on several sources. The body depth is given as $4\frac{1}{2}$–5 times in length, which is too slender for *S. bulan* or *H. vittatus*, but might apply to *S. jussieu* or *S. fimbriata*. *Harengula bulan* of Fowler (1956) and of Tortonese (1947) were based on Klunzinger's *Clupea kowal*. I have omitted all three references from the synonymies.

It seems likely that the genus *Kowala*, known otherwise from India and eastwards to China, is not present in the Western Indian Ocean, all previous records having been based on species of *Herklotsichthys* or *Sardinella*.

K. albella Valenciennes, the type of the genus *Kowala*, is a species of *Sardinella* ; however, *Escualosa* Whitley, 1940, was based on the second of Valenciennes' species, *K. thoracata*, and therefore replaces the name *Kowala* for that species (Whitehead 1964c).

Description : based on sixteen fishes, 75–101 mm., from Alayu (Gulf of Aden) ; and Rüppell's specimen of *Clupea kowal* from the Red Sea.

In percentages of standard length : body depth 27·7–31·2, head length 25·7–27·8 ;

snout length (6·6) 7·1–7·8, eye diameter 7·0–7·7, post-orbital distance 10·6–11·5, upper jaw length 9·6–10·8 ; pectoral length 17·0–20·5, pelvic length 10·2–11·7 ; pre-dorsal distance 44·7–49·2, pre-pelvic distance 53·0–55·2, pre-anal distance 77·0–79·1.

Fronto-parietal striae more irregular and numerous than in *H. punctatus*, about 5–7. Second supra-maxilla smaller than in *H. punctatus* and nearer to the *Sardinella* shape, i.e. lower part of expanded portion only slightly larger than upper part.

Dorsal iv–v (11) 12–15, pectoral i 12–13 (14), pelvic i 7, anal ii–iii (15) 16–17 (total 18–20). Abdominal scutes, pre-pelvic 16–17, post-pelvic 12–13, total (28) 29–30. Scales caducous 40–42 in lateral series (Regan). Gillrakers on lower part of first arch 45–57, increasing with size of fish (46 in a 65 mm. fish, 50 at 80 mm., 57 at 101 mm.).

Colour : in alcohol, dorsal surfaces dark, flanks paler, or silvery. Distinguished from *H. punctatus* by black or dark brown caudal tips, visible in most specimens.

Size : 101 mm. (Gulf of Aden).

Range : Red Sea (Jiddah, Massawa, i.e. Rüppell's *Clupea kowal* records), Gulf of Aden (Alayu, Ras Antara), but no records from the Persian Gulf or Gulf of Oman ; elsewhere, Indian Ocean from Red Sea to East Indies, also Philippines, Melanesia, Micronesia, Polynesia.

Specimens:

40 fishes, 65–101 mm., Alayu (surf cast-net) (B.M.N.H. 1962.3.26.160–199).
2 fishes, 32–33 mm., Ras Antara (B.M.N.H. 1962.3.26.200–201).
1 fish, 77 mm., Rüppell's *Clupea kowal*, Red Sea (N.-M.F.-I.S. SMF 560).

Rüppell's *C. kowal*, the only Red Sea specimen of *H. vittatus*, differs from the Gulf of Aden fishes in having slightly more branched rays in the dorsal and the pectoral fins (15 and 14 ; cf 12–13 and 12–13 respectively) ; in this respect it approaches *H. punctatus*, but it has more gillrakers (55).

SARDINELLA Valenciennes, 1847

Sardinella Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 28 (Type : *Sardinella aurita* Valenciennes, designated by Gill, 1861, *Proc. Acad. nat. Sci. Philad.* : 35).

Clupeonia Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 345 (Type : *Clupanodon jussieu* Lacepède, designated by Gill, *op. cit.* : 35).

Kowala Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : 362 (Type : *K. albella* Valenciennes = *Sardinella brachysoma* Bleeker—see Whitehead 1964c).

Amblygaster Bleeker, 1849, *J. Ind. Arch.*, **3** : 73 (Type : *Amblygaster clupeoides* Bleeker = *Clupea sirm* Walbaum—see Bertin 1944b).

Clupalosa Bleeker, 1849, *Verh. Bat. Gen.*, **22** : 12 (Type : *Clupalosa bulan* Bleeker—see note below).

Paralosa Bleeker, 1868, *Versl. Akad. Amst.*, **2** (2) : 300 (Type : *Harengula* (*Paralosa*) *valenciennesi* = *Sardinella melanura* (Cuvier)—see note below).

Wilkesina Fowler & Bean, 1923, *Proc. U.S. nat. Mus.*, **63** : 3 (Type : *Harengula fijiense* Fowler & Bean = *Sardinella nymphaea* (Richardson)—see note below).

Note on synonymy.

The names *Kowala*, *Clupalosa*, *Paralosa* and *Wilkesina* have been added to this synonymy as a result of examination of type material (Whitehead 1964a, c).

Some authors (e.g. Bertin 1944b) favour splitting *Sardinella* into three subgenera : *Sardinella* (for *S. aurita* and *S. longiceps*), *Amblygaster* (for *S. sirm* and *S. leiogaster*) and *Clupeonia* (for the remaining species). The genus is, however, badly in need of revision and I have preferred to ignore these subgeneric divisions for the time being.

The species of *Sardinella* are distinguished chiefly by differences in gillraker count and body depth. Study of material from the whole Indo-Pacific region may well reduce several species to subspecies or mere geographical forms. Fowler (1956) lists nine Red Sea or Persian Gulf species. I have recognised six species from this area, of which only three, *S. sirm*, *S. jussieu* and *S. fimbriata*, are definitely known from the Red Sea itself.

KEY TO THE SPECIES OF SARDINELLA

A Abdominal scutes keeled and well-exposed.

1 Pelvic rays 9 ; dark spot on upper angle of operculum ; gillrakers 180–250 ***S. longiceps***

2 Pelvic rays 8 ; dark spot often at base of unbranched dorsal rays ; gillrakers less than 180.

a. Gillrakers 45–57 ; body deep, 33–36% of S.L. ***S. bulan*** (= ***S. perforata auct.***)

b. Gillrakers 70–166 ; body variable, 24–34% of S.L. . . ***S. maderensis***

c. Gillrakers 53–72 ; body slender, 23–31% of S.L.

i. Gillrakers 53–58 (at 97–114 mm. S.L.) ; snout 6·4–7·3% of S.L. ***S. jussieu***

ii. Gillrakers 60–72 (at 87–118 mm. S.L.) ; snout 7·3–8·0% of S.L. ***S. fimbriata***

B Abdominal scutes feebly keeled, barely exposed, belly smooth ; gillrakers 38–45 ***S. sirm***

Sardinella longiceps Valenciennes

Sardinella longiceps Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : (198) 273 (Type locality : Pondicherry) ; Regan, 1917, *Ann. Mag. nat. Hist.*, (8) **19** : 379 (Muscat) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 65 (Indo-Pacific specimens).

Clupea longiceps : Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 167 (E. Arabia).

Clupea scombrina : Boulenger, 1887, *Proc. zool. Soc. London* : 666 (Muscat).

DESCRIPTION : based on twenty-five fishes, 79–136 mm., from Aden and Abyan (no Red Sea material).

In percentages of standard length : body depth 22·1–24·7, head length 30·0–33·8 ; snout length 7·5–8·7, eye diameter 6·0–7·6 (8·2), postorbital length 13·3–16·0, upper jaw length 11·8–12·9 ; pectoral length 16·2–17·9, pelvic length 9·0–9·9 ; pre-dorsal distance 46·0–50·0, pre-pelvic distance 53·5–59·0, pre-anal distance 78·0–82·0 (84·0).

Dorsal iv–v 13–14 (15), pectoral i 13–16, pelvic i 8, anal ii–iii 12–14 (total 15–16). Abdominal scutes, pre-pelvic (17) 18–19 (20), post-pelvic 13–15, total 32–33 (34). Scales caducous, 46 or 47 in lateral series (Fowler). Gillrakers fine, numerous, 180–250 on lower part of first arch (Regan).

Colour : in alcohol, dorsal surfaces dark, flanks silver, fins colourless except dark fringe to anal.

Length : 136 mm. (Gulf of Aden) ; 166 mm. (Fowler, 1956).

Range : Gulf of Aden (Aden, Abo, Ruqub, Abyan, Ras Antara), Gulf of Oman (Muscat), but no records from either the Red Sea or the Persian Gulf ; elsewhere, Indian Ocean and eastwards to Indonesia and Philippines (see Li 1960). *S. longiceps* replaces *S. aurita* in the Indian Ocean, but their ranges seem to overlap in Indonesia and the Philippines. No evidence that *S. aurita* from the Mediterranean has passed through the Suez Canal.

Specimens:

14 fishes, 79–101 mm., Aden (B.M.N.H. 1962.3.26.49–62).
7 fishes, 82–111 mm., Gulf of Aden (B.M.N.H. 1962.3.26.89–95).
1 fish, 142 mm., Abo, Somaliland (B.M.N.H. 1962.3.26.69).
12 fishes, 88 + 130–135 mm., Gulf of Aden (B.M.N.H. 1962.3.26.37–48).
9 fishes, 115–135 mm., Ruqub (B.M.N.H. 1962.3.26.10–18).
19 fishes, 123–136 mm., Abyan, Gulf of Aden (B.M.N.H. 1962.3.26.70–88).
6 fishes, 19–21 mm., Ras Antara, Somaliland (B.M.N.H. 1962.3.26.63–68).
3 fishes, 106–115 mm., Muscat, Arabia (Boulenger's *Clupea scombrina*) (B.M.N.H. 1887.11.11.314–316).

Sardinella bulan (Bleeker)
Hashinch, Moomagh (Iran)

Clupalosa bulan Bleeker, 1849, *Verh. Bat. Gen.*, **22** : 12 (Madura Strait, Kammal and Surabaya, Java).

Clupea (*Harengula*) *perforata* : Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 158 (Gischin).

Clupea perforata : Steindachner, *loc. cit.* : 167 (S. Arabia).

Sardinella perforata : Tortonese, 1934, *Boll. Mus. Zool. Anat. comp. Torino*, **44** (3) No. 49 : 5, fig. 1 (Persian Gulf) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 64 (N.W. of Jask ; S. Duwwan) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 65 (Indo-Pacific specimens).

Note on synonymy.

Regan (1917) placed *Clupalosa bulan* Bleeker and *Spratella kowala* Bleeker in the synonymy of *S. perforata* Cantor. Re-examination of the probable Bleeker holotypes of those two species (Whitehead 1964a) has shown that Regan correctly identified the two Bleeker specimens. However, Bleeker's *bulan* (1849) has priority over Cantor's *perforata* (1850) and should be used for this species (Whitehead 1964c).

Description : based on three fishes, 87–99 mm., from Ruqub (Gulf of Aden) ; two fishes, 89–90 mm., from the Gulf of Aden ; one fish, 77 mm., from Abyan ; and seven fishes, 74–97 mm., from the Persian Gulf.

In percentages of standard length : body depth 31·2–35·5, head length 24·8–27·0 ; snout length 5·8–6·7, eye diameter 7·1–8·4, post-orbital length (7·6) 8·6–9·6, upper

jaw length 10·3–11·5 ; pectoral length 19·1–21·2, pelvic length 10·5–12·9 ; pre-dorsal distance 43·0–46·6, pre-pelvic distance 52·0–55·8 (57·0) pre-anal distance 77·0–82·5 (85·0).

Dorsal iv 14–15, pectoral i (13) 14, pelvic i 7, anal iii 17–19. Abdominal scutes, pre-pelvic 18, post-pelvic 12–13 (14), total 30–31 (32). Scales in lateral series 37–41 (Fowler). Gillrakers on lower part of the first arch 47–54 (57) ; a slight indication that higher counts may occur in Gulf of Aden than in Persian Gulf fishes (independent of size).

	Gillrakers										
	47	*48*	*49*	*50*	*51*	*52*	*53*	*54*	*55*	*56*	*57*
Gulf of Aden . .		2	1	1				1			1
Persian Gulf . .	1		2			2	1				

Colour : in alcohol, upper surfaces dark brown, flanks silvery or paler brown. A dark spot at bases of unbranched dorsal rays and tips of these rays dusky, otherwise fins colourless. In some fishes the caudal tips appear faintly dusky.

Length : 99 mm. (Gulf of Aden) ; 143 mm. (Fowler).

Range : No Red Sea records, but known from Gulf of Aden (Qishn, Ruqub, Abyan), Persian Gulf (Duwwan) and Gulf of Oman (Jask) ; elsewhere, recorded (as *S. perforata*) from the East Indies, Philippines, Siam, Amoy, Polynesia. The only Indian Ocean record appears to be *Clupea kowal* Günther 1868 (Zanzibar, a skin) ; I have now examined further examples of this species from Zanzibar.

Specimens:

3 fishes, 87–99 mm., Ruqub, Gulf of Aden (B.M.N.H. 1962.3.26.96–98).
2 fishes, 89–90 mm., Gulf of Aden (B.M.N.H. 1962.3.26.99–100).
1 fish, 77 mm., Abyan, Gulf of Aden (B.M.N.H. 1962.3.26.101).
4 fishes, 91–97 mm., N.W. of Jask and S. of Duwwan. (Blegvad's *S. perforata*, Z.M.C. CN 8–11).
3 fishes, 74–80 mm., Persian Gulf (B.M.N.H. 1869.3.4.31–33).

Sardinella maderensis (Lowe)

Clupea maderensis Lowe, 1836, *Trans. zool. Soc. London*, **2** (3) : 189 (Type locality : Madeira).
Harengula maderensis : Jordan and Hubbs, 1917, *Ann. Carnegie Mus.*, **9** (3–4) : 461 (Port Said).
Sardinella maderensis : Chabanaud, 1933, *Bull. Soc. zool. France*, **58** : 288 (L. Timsah, Suez Canal) ; *Idem*, 1934, *Bull. Mus. Hist. nat. Paris*, (2) **6** (1) : 156 (*idem*) ; Gruvel, 1936, *Mém. Inst. Egypte*, **29** : 152 (Suez Canal) ; Gruvel and Chabanaud, 1937, *loc. cit.*, **35** : 2, fig. 2 (Port Said ; L. Amer, Suez Canal) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 66 (Canaries, Syria).
Sardinella (*Clupeonia*) *maderensis* : Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **15** (6) : 388 (L. Timsah, L. Amer).
Sardinella (*Clupea*) *granigera* : Tillier, 1902, *Mém. Soc. zool. France*, **15** : 295 (L. Timsah).
Harengula granigera : Fowler, 1923, *Proc. Acad. nat. Sci. Philad.*, **75** : 35 (Beirut, Syria).
Sardinella eba : Norman, 1927, *Trans. zool. Soc. London*, **22** (3) : 376 (L. Timsah) ; Chabanaud, 1932, *Bull. Mus. Hist. nat. Paris*, (2) **4** (7) : 832 (L. Amer).
Clupea (*Sardinella*) *eba* : Gruvel, 1936, *Mém. Inst. Egypte*, **29** : 152 (L. Timsah ; L. Amer.)

Note on synonymy.

Ben-Tuvia (1959) concluded that only differences in body depth separate the types of *S. maderensis*, *S. eba* (Valenciennes), *S. granigera* (Valenciennes) and *S. cameronensis* Regan ; and that body depth is too variable a character on which to base these species. However, Tortonese (1961) believed that *S. maderensis* and *S. granigera* are distinct, but he placed *S. eba* in the synonymy of the latter.

Description : based on Ben-Tuvia (1959), but proportional measurements converted to percentages.

In percentages of standard length ; body depth 24·4–34·5 (see also Ben-Tuvia 1959, Table 1), head length 22·2–29·5 ; pre-dorsal distance 40·0–47·5, pre-pelvic distance 45·5–55·5, pre-anal distance 66·5–91·0 ; distance pectoral to pelvic 23·2–30·3, distance pelvic to anal 21·2–27·0. In percentages of head length : snout 23·8–31·2, eye diameter 22·2–32·2, interorbital width 17·3–25·7, maxilla length 33·3–47·5 ; pectoral length 55·5–83·0, pelvic length 34·5–47·5.

Dorsal 17–21, pectoral i 13–i 16, pelvic i 7, anal 17–22. Abdominal scutes, pre-pelvic 18–20, post-pelvic 13–15, total 31–34. Scales in lateral series 40–50. Gillrakers 70–166 in fishes over 60 mm., increasing with size of fish.

Colour : " (fresh) : back grey-blue, sides and belly silvery. Top of head and tip of snout dark. Cheeks and opercular region silvery white with blue-green irridescence. A dark diffused blotch behind the upper hind border of the branchial opening. Immediately posterior to this blotch, a narrow golden band stretches along the body to the caudal fin, parallel to the fourth or fifth row of scales. Additional golden streaks less distinct and narrower run parallel above and below this band. Dorsal fin dusky yellow with a black spot at the base of the first five rays. Anal and ventrals whitish. Pectorals dusky. Caudal fin dusky, becoming darker towards the tips ". (Ben-Tuvia 1959).

Length : up to 275 mm. (Ben-Tuvia 1959).

Range : Port Said, Suez Canal, L. Timsah, L. Amer, but not recorded from Gulf of Suez or Red Sea ; elsewhere, Mediterranean, Eastern Atlantic (Madeira, Cameroons).

Specimens :

1 fish, 127 mm., L. Timsah (B.M.N.H. 1925.9.19.4).

2 fishes, 69–71 mm., between Port Said and Damietta (B.M.N.H. 1928.11.30. 1–2).

Sardinella jussieu (Lacepède)

Clupanodon jussieu Lacepède, 1803, *Hist. Nat. Poiss.*, **5** : 469, 474, pl. 11, fig. 2 (Type locality : Mauritius).

Sardinella jussieu : Fowler, 1941, *Fishes of the Red Sea*, **1** : 67 (Indo-Pacific specimens).

Clupea fimbriata : Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 158 (Gischin, S. Arabia).

Harengula dollfusi Chabanaud, 1933, *Bull. Inst. océanogr. Monaco*, No. 627 : 1, fig. 1 (gillraker, tongue), fig. 2, scale (Gulf of Suez) ; Fowler, 1941, *Bull. U.S. nat. Mus.*, No. 100 : 600 (compiled) ; Tortonese, 1947, *Boll. Soc. Adriat. Sci. nat. Trieste*, **43** : 82 (compiled).

Sardinella (*Clupeonia*) *gibbosa* : Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **15** (6) : 389 (Suez Canal ; Gulf of Suez).
Sardinella sindensis : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 65 (Gulf of Oman).

Note on synonymy.

Regan (1917) and some later authors have rather doubtfully identified *Clupanodon jussieu* Lacepède with this species and have preferred to use Bleeker's name *gibbosa* instead. Valenciennes (1847) claimed to have examined specimens similar to those of Commerson (Lacepède's description was based on Commerson's notes), and he notes that the operculum shows " *stries rayonnantes, fines et nombreuses* ". In no species of either *Sardinella* or *Harengula*, however, is the operculum striated ; the appearance of striae can be given by the much branched cephalic sensory canal system on the operculum, but this is common in both genera and would hardly call for comment. Valenciennes (*loc. cit.* p. 349) described a second species, *Clupeonia fasciata*, which he believed almost identical to his *C. jussieu* but lacking the opercular striae, and with two less anal rays. The description of *C. fasciata* agrees well with the present species, and Fowler (1941) placed it in the synonymy of *Sardinella jussieu*. It has priority over *S. gibbosa* (Bleeker), 1849, and should be used if *Clupanodon jussieu* Lacepède should prove to be a *nomen dubium*.

I have not examined specimens of *Harengula dollfusi* but have accepted Bertin's (1943b) synonymy ; Dr. M. Blanc has been unable to locate these types in the Museum National d'Histoire Naturelle.

S. sindensis (Day) differs from *S. jussieu* in having slightly more gillrakers (58–62 ; *cf.* 50–55 (Fowler), 53–57 in my material). Blegvad's single specimen of *S. sindensis* has 55 gillrakers. *S. sindensis* can perhaps be considered a synonym of *S. jussieu*, representing an eastern form or subspecies.

Description : based on six fishes, 97–114 mm., from Mukalla ; four fishes, 99–115 mm., from Mukalla ; and one fish, 119 mm., from the Gulf of Oman (Blegvad's *S. sindensis*).

In percentages of standard length : body depth 24·3–27·4, head length 24·3–26·9 ; snout length (6·4) 6·9–7·3, eye diameter (6·3) 6·6–7·5, post-orbital (8·6) 9·3–10·1, upper jaw length 9·4–10·8 ; pectoral length (16·4) 17·6–18·0, pelvic length (8·8) 9·9–10·4 ; pre-dorsal distance 42·5–47·6, pre-pelvic distance 48·8–54·0, pre-anal distance 78·3–81·5.

Dorsal iv 14–15, pectoral i 13–14, pelvic i 7, anal iii (14) 15–17. Abdominal scutes, pre-pelvic (17) 18 (19), post-pelvic (14) 15, total 32–33 (34). Scales caducous, 40–42 in lateral series (Fowler).

Gillrakers 53 (f.2) 54 (4) 55 (5) 56 (1) 57 (2), mean 54·88.

Colour: in alcohol, upper surfaces grey/blue or dark brown, flanks silvery or pale brown. A prominent dark spot at bases of unbranched dorsal rays, otherwise fins colourless.

Length : 119 mm. (Gulf of Oman) ; 178 mm. (Fowler).

RANGE : Suez Canal, Red Sea (Gulf of Suez), Gulf of Aden (Mukalla, Qishm, Aden), Gulf of Oman, but not recorded from the Persian Gulf ; elsewhere, Indian Ocean from Mauritius to East Indies, and from China, Australia, Micronesia, Polynesia.

Specimens :

6 fishes, 97–114 mm., Mukalla (B.M.N.H. 1962.3.26.102–107).
6 fishes, 99–115 mm., Mukalla (B.M.N.H. 1962.3.26.111–116).
3 fishes, 54–58 mm., Aden (B.M.N.H. 1962.3.26.108–110).
1 fish, 119 mm., Gulf of Oman (Z.M.C. C1—Blegvad's *S. sindensis*).
2 fishes, 118–119 mm., Gischin, coll. Hein (N.M.V. 1260).

Sardinella fimbriata (Valenciennes)

Sefer, Hashinch, Moomagh (Iran)

Spratella fimbriata Valenciennes, 1847, *Hist. Nat. Poiss.*, **20** : (263) 359, pl. 601 (Type locality : Malabar).

Sardinella fimbriata : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 65, fig. 29 (copied Day) (off Fort Dilam) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 66 (on Philippine specimens).

Note on synonymy.

Bertin (1944b), after an examination of the Valenciennes types of *Clupeonia jussieui* and *Spratella fimbriata*, concluded that the two represented a single species, which he believed to have " environ 70 branchiospines à la branche inférieure du premier arc branchial ". But, until the validity and identity of Lacepède's *C. jussieu* can be definitely confirmed or rejected, it seems best to retain the name *fimbriata* for the material described here.

S. jussieu (as understood here, i.e. *sensu* Fowler, 1941, 1956) very closely resembles *S. fimbriata*. Dutt (1961a, 1962), who studied the two species off the Waltair Coast of India, stated that *S. fimbriata* makes its appearance there earlier than *S. gibbosa* (i.e. *S. jussieu*), but that at times when the two species coincide, their shoals are almost always discrete (Dutt 1962). He distinguished the two species on gillraker counts which, although increasing slightly with size of fish, remain just distinct (a difference of 2, 2, 3, 6, 6, 5, 8, 5, 2, 4, 0, 4 rakers respectively in the 10 mm. groups 30–140 mm. standard length).

In my material (24 fishes, 87–118 mm.) I have assigned specimens with a count of 53–58 rakers to *S. jussieu*, and those with 60–72 rakers to *S. fimbriata*. In this size range, Dutt's ranges in gillraker counts are respectively 43–60 and 57–77, with average values of 48, 52, 53, 56 for *S. jussieu* and 63, 66, 69, 70 for *S. fimbriata* in the 10 mm. groups represented (mean values of 54·9 and 66·5 respectively in my material).

In the specimens examined here, there are no other meristic differences between the two species, and proportional measurements are almost identical except for a slightly shorter snout in *S. jussieu* (6·4–7·3 per cent. of S.L. ; cf. (6·7) 7·3–8·0 in *S. fimbriata*). Fowler (1956) finds a difference in numbers of scales in lateral series, *S. fimbriata* having a lower count (36–38 ; cf. 40–42), but counts are not always possible or perhaps accurate in these fishes.

Both species have now been recorded from the Persian Gulf area (the record of *S. jussieu* being based solely on Blegvad's Gulf of Oman specimen of *S. sindensis*) ; *S. jussieu* is now recorded from the Gulf of Aden and the Red Sea (as *H. dollfusi*), while *S. fimbriata* is recorded from the Red Sea but not the Gulf of Aden. Gillraker counts within these localities are still consistent with the hypothesis that two species are present in the area.

Numbers of rakers

	Red Sea	Gulf of Aden	Persian Gulf area
S. jussieu	53–56 (Chabanaud 1933)	53–57 (12)	55 (1) (Gulf of Oman)
S. fimbriata	60, 62 (2)	—	60–72 (20)

In conclusion, it can be said that Regan's (1917a) Indian specimens of *S. fimbriata* had counts of 70–75 rakers, while Fowler's (1941) Philippine specimens had 80 rakers. Such variations in number of rakers may further complicate the distinction between the two species, and the problem cannot be resolved on the basis of such small samples as the present one.

Description : based on twenty fishes, 87–118 mm., from the Persian Gulf ; two fishes, 114–115 mm., from off Fort Dilam, Persian Gulf (Blegvad's specimens of *S. fimbriata*), and two fishes, 93–101 mm., southern Red Sea.

In percentages of standard length : body depth 23·0–25·4 (27·6–29·8), head length 25·2–27·8 ; snout length (6·7) 7·3–8·0, eye diameter 6·5–7·6, post-orbital distance 9·0–10·6, upper jaw length 9·9–11·1 ; pectoral length 16·1–18·9, pelvic length 8·8–10·4 ; pre-dorsal distance 43·3–47·2 ; pre-pelvic distance 49·2–54·8, pre-anal distance 77·0–80·5.

Dorsal iv 14–15 (16), pectoral i 13–15, pelvic i 7, anal ii–iii 15–17 (total 17–20). Abdominal scutes, pre-pelvic (17) 18, post-pelvic 14–15 (16), total 32–33 (34). Scales caducous, 36–38 in lateral series (Fowler). Gillrakers, 60 (f. 4), 61 (1), 62 (1), 63 (2), 64 (2), 65 (4), 66 (3), 67 (1), 68 (2), 69 (1) and 70 (1), mean 64·75 (72 in one fish).

Colour : in alcohol, upper surfaces dark blue/grey or dark brown, flanks silvery or pale brown. A faint dark spot at bases of unbranched dorsal rays (as in *S. jussieu*), otherwise fins colourless (" caudal tip dark "—Fowler 1956).

Length : 118 mm. (Persian Gulf) ; 135 mm. (Philippines—Fowler).

Range : Persian Gulf (off Fort Dilam), and from Red Sea (North of Mt. Guba) ; elsewhere, Indian Ocean (India to East Indies), Philippines, China.

Specimens :

41 fishes, 87–118 mm., Persian Gulf (B.M.N.H. 1962.10.20.1–41).
2 fishes, 114–115 mm., off Fort Dilam, Persian Gulf (Z.M.C. CN 2 and 3, Blegvad's *S. fimbriata*).
1 fish, 102 mm., S. Red Sea (H.U. E58/305).
1 fish, 94 mm., north of Mt. Guba, Red Sea (H.U. E57/715).

Sardinella sirm (Walbaum)
(Aenab.)

Clupea sirm Walbaum, 1792, *Artedi Pisc.*, **3** : 38 (on Forskål, 1775, *Descript. Animal.* 17—Arabia) ; Rüppell, 1837, *Neue Wirbelth., Fische* : 77, pl. 21, fig. 1 (Massaua) ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 598 (Red Sea).

Alosa sirm : Günther, 1866, *Fishes of Zanzibar* : 123 (Red Sea).

Sardinella sirm : Tortonese, 1935, *Boll. Mus. Zool. Anat. Comp. Un. Torino*, ser. 3, **45** (6) : 13, fig. 1 (scale) (Massaua) ; Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116, fig. 2 (Red Sea) ; Tortonese, 1947, *Boll. Soc. Adriat. Sci. nat. Trieste*, **43** : 82 (Massaua).

Sardinella (*Amblygaster*) *sirm* : Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, ser. 2, **15** (6) : 389 (Gulf of Suez).

Clupea liogaster : Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 598 (Kosier, Red Sea) ; Steindachner, 1871, *Denkschr. Wiss. Wien*, **71** (1) : 158 (Makalla ; Gulf of Aden), 167 (S. Arabia).

Sardinella leiogaster : Tortonese, 1947, *Boll. Soc. Adriat. Sci. nat. Trieste*, **43** : 82 (Red Sea).

Harengula bipunctata Ehrenberg : in Klunzinger, *loc. cit.* : 599 (name in synonymy).

? *Sardinella clupeoides* : Fowler, (*part.*), 1941, *Bull. U.S. nat. Mus.*, No. 100 : 619 (Red Sea specimen only) ; Tortonese, 1947, *Boll. Soc. Adriat. Sci. nat. Trieste*, **43** : 82 (on Fowler) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 68 (on Fowler 1941).

Note on synonymy.

Fowler (1941) records " 32? " gillrakers in a single specimen from the Red Sea, and places this specimen in *S. clupeoides* (Bleeker). Since this is only 5 rakers less than the lowest recorded here for *S. sirm*, and since *Amblygaster clupeoides* Bleeker, 1849, was described from the East Indies, it seems possible that Fowler's count was incorrect. Gillraker numbers may increase with size of fish, but Fowler's specimen was large enough (126 mm.) to have an adult count. Tortonese (1947) followed Fowler in listing *S. clupeoides* for the Red Sea. Bertin (1944b), having examined type material, claimed that *S. leiogaster* Valenciennes 1847, is identical to and has priority over *S. clupeoides* ; hitherto, authors (e.g. Regan 1917) have placed *S. leiogaster* in the synonymy of *S. sirm*.

Description : based on two fishes, 129–147 mm., from Massawa (collected by Rüppell) ; four fishes, 105–126 mm., from Mukalla, Gulf of Aden ; one fish, 120 mm., from Abo, Somaliland ; and one fish, 109 mm., from Eritrea.

In percentages of standard length : body depth 19·4–24·3, head length 24·0–26·2 ; snout length 7·1–8·8, eye diameter 6·0–7·2, upper jaw length 8·9–9·8, post-orbital distance 8·6–9·5 ; pectoral length 14·3–17·0, pelvic length 8·5–9·9 ; pre-dorsal distance 44·2–46·2, pre-pelvic distance 49·4–53·0, pre-anal distance 78·4–81·0.

Abdominal scutes present, but with very poorly developed keels so that belly feels smooth.

Dorsal iv 14–15, pectoral i 15–16, pelvic i 7, anal ii or iii 15–16 (total 18–19). Abdominal scutes, pre-pelvic 17–18, post-pelvic 14–15, total 31–33. Scales caducous, 42–45 in lateral series (Regan). Gillrakers, 38 (1), 39 (1), 40 (1), 41 (1), 42 (3), 45 (1) on lower part of first arch ; only 35 gillrakers in a 63 mm. specimen from Zanzibar.

Colour : in alcohol, upper surfaces grey-blue or dark brown, flanks silvery, fins colourless.

Size : 147 mm. (Massawa) ; up to 280 mm. (Fowler 1956).

Range : Red Sea (Massawa, Gulf of Suez, Quseir, Shab Sheikh), Gulf of Aden (Abo, Mukalla), but not from the Persian Gulf or Gulf of Oman ; elsewhere, Indian Ocean (Zanzibar to East Indies), Philippines, China, Micronesia, Polynesia.

Specimens :

4 fishes, 105–126 mm., Mukalla (B.M.N.H. 1962.3.26.119–122).
1 fish, 120 mm., Abo, Somaliland (B.M.N.H. 1962.3.26.118).
1 fish, 109 mm., Shab Sheikh, Eritrea (from stomach of *Euthynnus affinis*) (H.U. E57/690).
2 fishes, 129–147 mm., Massaua, Rüppell's specimens (N.-M.F.-I.S. 458).

Subfamily Alosinae

Of the two Indo-Pacific alosinid genera, *Hilsa* and *Gudusia*, only the former is represented in the Red Sea area. There is as yet no record of *Hilsa* from the Red Sea itself, only from the Persian Gulf and the Gulf of Aden. Since *H. ilisha* (and probably *H. kelee* also) spawns in rivers, it is unlikely that anything more than stray individuals can be expected in the Red Sea. In the Persian Gulf, on the other hand, shoals of *H. ilisha* ascend the Tigris and Euphrates (Mahdi 1962).

H. kelee differs from all other species in several respects and can be placed in a separate subgenus (Whitehead, 1965).

Revisions : Regan (1917), Whitehead (1965).

Key to the Subgenera

1 Fronto-parietal region with numerous exposed striae ; no pectoral axillary scale ; expanded portion of maxilla with several longitudinal ridges . . subgenus ***Hilsa***

2 Fronto-parietal region covered with thick skin, few or no striae ; pectoral axillary scale present ; expanded portion of maxilla smooth or with fine striae subgenus ***Tenualosa***

HILSA Regan, 1917

Paralosa Regan (*non Paralosa* Bleeker), 1916, *Ann. Durban Mus.*, **1** : 167 (Type : *Clupea durbanensis* Regan).

Hilsa Regan, 1917, *Ann. Mag. nat. Hist.*, (8) **19** : 303 (Type : *Clupea durbanensis* Regan).

Tenualosa Fowler, 1934, *Proc. Acad. nat. Sci. Philad.*, **85** : 246 (Type : *Alosa reevesii* Richardson).

Macrura Fowler, (*non Macrura* van Hasselt), 1941, *Bull. U.S. nat. Mus.*, No. 100 : 626 (Type : *Clupea kelee* Cuvier).

Subgenus ***Hilsa***

Hilsa kelee (Cuvier)

Clupea kelee Cuvier, 1829, *Règne Animal*, ed. 2, **2** : 320 (name in footnote, based on *Keelee* Russell, 1803, *Fishes of Coromandel*, **2** : 75, pl. 195—Type locality : Vizagapatam).

Macrura kelee : Fowler, 1956, *Fishes of the Red Sea*, **1** : 69 (Indo-Pacific specimens).

Hilsa kelee : Whitehead, 1965, *Bull. Brit. Mus. nat. Hist. (Zool.)*, **12** (4): 129 (Gulf of Aden and Indo-Pacific specimens).

Alosa chapra : Günther, 1866, *Fishes of Zanzibar* : 123 (Aden) (misidentification).

Hilsa kanagurta : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 63 (N. of Farur).

Note on synonymy.

As I have shown elsewhere (Whitehead 1965), Fowler (1941) was mistaken in using van Hasselt's name *Macrura* in a generic sense.

Description : based on four fishes, 129·2–133·2 mm., from Aden ; and two fishes, 80·2–90·0 mm., from Jibuti.

In percentages of standard length : body depth 37·4–41·5, head length 33·0–36·1 ; snout length 7·5–8·5, eye diameter 8·3–9·5, upper jaw length (from snout tip) 14·3–16·4 ; pectoral length 20·4–21·0, pelvic length 10·9–12·0 ; pre-dorsal distance 47·5–50·5, pre-pelvic distance 54·5–57·5 ; operculum height 18·2–20·6, width 8·6–10·0.

Fronto-parietal area exposed, striated (as in *Sardinella*). Expanded portion of maxilla with several longitudinal ridges. No pectoral axillary scale.

Dorsal iv 13–14, pelvic i 7, anal iii 18–19. Abdominal scutes, pre-pelvic 16, post-pelvic 13, total 29.

Colour : in alcohol, back and upper part of head brown, flanks silvery. A dark humeral blotch, followed (in some specimens) by seven or eight black blotches. Tips of anterior dorsal rays dusky, as also caudal tips.

Length : Aden specimens up to 133 mm. (South African specimens up to 180 mm.).

Range : Persian Gulf (Farur) and Gulf of Aden (Aden, Djibuti), but no records from Red Sea itself ; elsewhere, Western Indo-Pacific region from Natal to Burma and Siam.

Specimens :

4 fishes, 129–133 mm., Aden (B.M.N.H. 1962.3.26.202–205).
5 fishes, 65–91 mm., Jibuti (B.M.N.H. 1962.3.26.206–210).

Subgenus ***Tenualosa***

Hilsa ilisha (Hamilton-Buchanan)

Clupanodon ilisha Hamilton-Buchanan, 1822, *Fishes of the Ganges* : 243, 382, pl. 19, fig. 73 (Type material from : Ganges estuaries ; Patua ; Goyakarra ; Calcutta ; Dhasa).
Clupea ilisha : Day, 1878, *Fishes of India*, pt. 4 : 640, pl. 172, fig. 3 (Tigris).
Hilsa ilisha : Regan, 1917, *Ann. Mag. nat. Hist.*, (8) **19** : 306 (Persian Gulf, Burma) ; Hora & Misra, 1943, *J. Roy. Asiatic Soc. Bengal*, **9** : 2 (Persian Gulf ?) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 63, fig. 28 (photo) (Bushire) ; Menon, 1960, *Rec. Indian Mus.*, **54** (3–4) : 141 (Habanian) ; Mahdi, 1962, *Fishes of Iraq* : 11 (Tigris, Euphrates) ; Khalaf, 1962, *Mar. f-water fishes of Iraq* : 17 (Persian Gulf) ; Whitehead, 1965, *Bull. Brit. Mus. nat. Hist.* (*Zool.*), **12** (4) : 134 (Tigris, Basra, and Indian specimens).
Macrura ilisha : Fowler, 1956, *Fishes of the Red Sea*, **1** : 69 (copied from Regan).

Description : based on three fishes, 100–127 mm., from Basra ; and three fishes, 115–131 mm., from the Tigris ; no Red Sea material.

In percentages of standard length : body depth 31·0–36·0, head length 28·6–32·5 ; snout length 6·6–7·0, eye diameter 6·0–7·1, upper jaw length 12·3–14·5 ; operculum, height 14·4–15·7, width 7·5–9·2 ; pre-dorsal distance 47·8–49·5, pre-pelvic distance 51·5–53·5 ; caudal length 33·2 (one fish only).

Fronto-parietal area covered by thick skin, no striae but sometimes one or two lateral ridges. Expanded portion of maxilla smooth. Pectoral axillary scale present.

Dorsal iv or v 15–16, pectoral i 13–15, pelvic i 7, anal iii 17–18. Abdominal scutes, pre-pelvic (16) 17, post-pelvic 14–15, total (30) 31–32.

Length : largest specimen examined 360 mm. ; Mahdi (1962) gives 250–350 mm. and Khalaf (1962) 400 mm., but it is not indicated whether this applies to Iraq fishes. Elsewhere, fishes of up to 600 mm. (females) have been recorded (Chacko and Ganapati 1949).

Range : Persian Gulf (Tigris, Euphrates, Basra, Bushehr) but no Gulf of Aden or Red Sea records ; elsewhere, Indian Ocean eastwards to Burma and Cochin China.

Bionomics, fishery, etc. : a full review of the fisheries and existing knowledge concerning this species has been published recently (Pillay and Rosa 1963).

Specimens. 3 fishes, 115–131 mm., Tigris (B.M.N.H. 1875.1.14.11–13). 6 fishes, 99–127 mm., Basra (B.M.N.H. 1920.3.3.178–182). (Dry specimens). 1 fish, 350 mm., Tigris (B.M.N.H. 1875.1.14.14). 1 fish, 360 mm., Tigris (B.M.N.H. 1875.1.14.15).

Subfamily Pristigasterinae

OPISTHOPTERUS Gill, 1861

Opisthopterus Gill, 1861, *Proc. Acad. nat. Sci. Philad.* : 38 (Type : *Pristigaster tartoor* Valenciennes).

A single species in this area.

Opisthopterus tardoore (Cuvier)

Pristigaster tardoore Cuvier, 1829, *Règne Animal*, ed. 2, **2** : 321 (on *Tartoore* Russell, 1803, *Fishes of Coromandel*, **2** : 74, pl. 103 : Vizagapatam).
Opisthopterus tardoore : Fowler, 1956, *Fishes of the Red Sea*, **1** : 70 (Indo-Pacific specimens).
Opisthopterus tartus : Zugmayer, 1913, *Abhandl. Bayer. Akad. Wiss.*, **26** (6) : 9 (Oman).
Opisthopterus indicus : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 68, fig. 31 (copied Day) (off Jask).

Description : based on a single fish, 136 mm., Blegvad's specimen from near Jask, Gulf of Oman.

In percentages of standard length : body depth 31·5, head length 21·2 ; snout length 5·2, eye diameter 6·5, upper jaw length 12·0, lower jaw length 10·8 ; pectoral length 23·5 ; pre-dorsal distance 65·2, pre-anal distance 54·3, length of anal base 48·5.

Dorsal iv 12, pectoral i 13, anal iii 54. Abdominal scutes 29. Branchiostegal rays 6. Gillrakers, 25 on lower part of first arch.

Maxilla rounded posteriorly, projecting beyond posterior tip of second supramaxilla. Dorsal origin well behind anal origin ; pelvic fins entirely absent.

Colour : " Uniform pale brown. Dusky brown median streak down back. Top of head and ends of jaws sprinkled with dusky dots. Iris and side of head silvery white. Fins pale. Pectoral and caudal with few dull dusky dots." (Fowler 1956).

SIZE : 136 mm. (208 mm. Fowler 1941).

RANGE : Gulf of Oman (Oman, Jask), but not from Persian Gulf, Red Sea or Gulf of Aden ; elsewhere, India, China, East Indies.

Specimens :

1 fish, 136 mm., off Jask, coll. Blegvad (Z.M.C. —C 1).

ILISHA Richardson, 1846

Ilisha (Gray) Richardson, 1846, *Ichth. China Japan* : 306 (Type : *Ilisha abnormis* (Gray) Richardson).

Platygaster Swainson, 1839, *Nat. Hist. Animals*, **2** : 294 (Type : *Clupea africana* Bloch) (*non Platygaster* Latreille 1809, Schilling 1829, Duméril and Bibron 1844).

Zunasia Jordan and Metz, 1913, *Mem. Carnegie Mus.*, **6** (1) : 7 (Type : *Pristigaster chinensis* Basilewsky).

Euplatygaster Fowler, 1934, *Proc. Acad. nat. Sci. Philad.*, **85** : 246 (Type : *Pellona brachysoma* Bleeker).

A single species recorded from this area.

Ilisha indica (Swainson)

Platygaster indicus Swainson, 1839, *Nat. Hist. Animals*, **2** : 294 (on *Ditchoee* Russell, 1803, *Fishes of Coromandel*, **2** : 74, pl. 192 [upper figure] ; Type locality : Vizagapatam).

Ilisha indica : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 67, fig. 30 (photo) (off Bushire, W. of Kharg, Bushire Roads).

? *Ilisha filigera* : Misra, 1947, *Rec. Indian Mus.*, **45** : 116 (Persian Gulf).

Misra's specimen of *I. filigera* may have been this species, but no description is given. Fowler (1941) places *I. filigera* in the second part of his key, i.e. those species with more than 46 scales and 20–28 pre-pelvic scutes. Scales are missing from the Blegvad specimens, but there are 20–22 pre-pelvic scutes. However, the Blegvad fishes are clearly distinct from the species included by Fowler in the second half of his key on a combination of characters (gillraker number, anal position, scute number, anal finray number), and in all these features they agree with *I. indica*. The genus *Ilisha* is badly in need of revision.

DESCRIPTION : based on three fishes, 155–188 mm., from the Persian Gulf.

In percentages of standard length : body depth 33·0–34·0, head length 25·4–26·5 ; snout length 6·5–7·4, eye diameter 7·8–8·6, upper jaw length 12·3–12·7, lower jaw length 12·1–13·0 ; pectoral length 17·4–17·9, pelvic length 5·1–5·3, anal base 30·5–32·2 ; pre-dorsal distance 47·7–49·5, pre-pelvic length 47·3–47·5, pre-anal length 66·0–68·0.

Dorsal iii 15–16, pectoral i 15–16, pelvic i 6, anal iii 39–40. Abdominal scutes, 20–22 pre-pelvic, 10 post-pelvic, total 30–32. Gillrakers on lower part of first arch 25–26.

COLOUR : in alcohol, a uniform pale brown, slightly darker along back, fins hyaline.

SIZE : 188 mm. (" up to 40 cm. " Blegvad 1944).

RANGE : Persian Gulf only (Bushehr, Kharg) ; elsewhere, East Africa, India, East Indies, China.

Specimens :

8 fishes, 61.5–72·5 and 155–188 mm., Persian Gulf, coll. Blegvad (Z.M.C. C 1–8).

Subfamily Dorosomatinae (Gizzard shads)

Five Indo-Pacific genera, two recorded from the Red Sea area, but not from the Red Sea itself. Genera reviewed by Whitehead (1962b).

Key to the Genera

1 Last dorsal ray produced as a filament . . . . . ***Nematalosa***
2 Last dorsal ray not produced . . . . . ***Anadontostoma***

NEMATALOSA Regan, 1917

Nematalosa Regan, 1917, *Ann. Mag. nat. Hist.*, (8) **19** : 313 (Type : *Clupea nasus* Bloch, designated by Jordan, 1920, *Genera of Fishes*, pt. 4 : 560).

Two species found in this area.

Key to Species

1 Snout not projecting greatly beyond tip of lower jaw ; maxilla not curved strongly downwards at tip ; second sub-orbital with oblique lower edge ; head longer, 29–32% of S.L. . . . . ***N. arabica***
2 Snout projecting well beyond tip of lower jaw, the mouth clearly inferior ; maxilla short, its tip curved strongly downwards ; second suborbital with vertical anterior edge ; head shorter, 25% of S.L. . . . . ***N. nasus***

Nematalosa arabica Regan

Nematalosa arabica Regan, 1917, *Ann. Mag. nat. Hist.*, (8) **19** : 313 (Muscat : Boulenger's Muscat specimen of *C. nasus*) ; Fowler, 1941, *Bull. U.S. nat. Mus.*, No. 100 : 554 (compiled) ; *Idem*, 1956, *Fishes of the Red Sea* : 60 (copied) ; Tortonese, 1957, *Boll. Mus. Civ. Stor. nat. Venezia*, **10** : 123 (Ras Hafur) ; Whitehead, 1962, *Bull. Brit. Mus. nat. Hist.*, **9** (2) : 98, figs. 1B, 2B, 3A (Muscat, Mukalla, Jibuti).

Chatoessus nasus Boulenger, 1887, *Proc. zool. Soc. London* : 66 (Muscat).

Description : based on the holotype, 131 mm. standard length from Muscat ; one fish, 150 mm., from Mukalla ; and six fishes, 94–101 mm., from Jibuti.

In percentages of standard length : body depth 36·0–40·5, head length 29·3–31·7, head depth at occiput 23·4–26·0 ; snout length 6·1–7·6, eye diameter 7·3–7·8, post-orbital distance 13·9–15·3, pre-maxilla length 4·5–5·7, upper jaw length 6·5–8·2 ; pectoral length 20·5–23·0, pelvic length 12·4–14·0, length of anal base 15·3–17·9 ; pre-dorsal distance 49·0–51·0, pre-pelvic distance 52·0–54·5 ; length of last (filamentous) dorsal ray 35·5–41·0 ; depth of caudal peduncle (11·0) 12·1–12·9.

Pre-maxilla 1·14–1·77 times in length of maxilla ; length of expanded portion of maxilla 2·40–3·40 times in the length of the whole bone, the depth of the expanded portion 2·57–3·13 times in maxilla length. Maxilla reaching to below anterior pupil border.

Gillrakers about half length of gill filaments on anterior arch ; anterior hemibranch equal or subequal to posterior hemibranch.

Dorsal iv–v 12–14 (total 17–18), anal ii–iii 15–17 (total 18–20) ; scales in lateral series 42–45 ; abdominal scutes, pre-pelvic 18–19, post-pelvic 13–15, total 32–34 ; vertebrae 46 (1 specimen).

Pelvic fin base below second or third branched dorsal ray ; pectoral tips reach or almost reach pelvic base. Sub-operculum roughly rectangular ; anterior margin of second sub-orbital with oblique lower edge.

Length : 150 mm.

Range : Gulf of Oman (Muscat), Gulf of Aden (Mukalla, Alayu, Ras Hafun and Djibuti), but no records from Red Sea itself or Persian Gulf. Not known outside this area.

Specimens :

1 fish, 131 mm., Holotype, Muscat (B.M.N.H. 1887.11.11.312).
1 fish, 150 mm., Mukalla (B.M.N.H. 1945.12.31.14).
6 fishes, 94–101 mm., Jibuti, Somaliland (B.M.N.H. 1962.3.13.1–6).
2 fishes, 51–52 mm., Alayu, Gulf of Aden (B.M.N.H. 1962.3.13.7–8).

Nematalosa nasus (Bloch)

Clupea nasus Bloch, 1795, *Naturgesch. Ausl. Fische*, **9** : 116, pl. 429, fig. 1 (Malabar).

Dorosoma nasus : Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 156 (Tamarida and Kor Garrieh, Gischin), 167 (S. and E. coasts Arabia) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 58, fig. 26 (copied Day) (Bushire Roads).

Nematalosa nasus : Misra, 1947, *Rec. Indian Mus.*, **45** : 116 (Hor-el-Hammar) ; Menon, 1960, *Rec. Indian Mus.*, **54** : 141 (Hor-el-Hammar) ; Mahdi, 1962, *Fishes of Iraq* : 13 (Hor-el-Hammar) ; Khalaf, 1962, *Mar. f-water fishes of Iraq* : 20 (Shatt-el-Arab, Hor-el-Hammar).

Description : based on two fishes, 97·5 and 152·0 mm., from Bushire, Persian Gulf (Blegvad's two specimens). Measurements for larger fish stated first.

In percentages of standard length : body depth 37·8 and 42·2, head length 24·8 and 25·2 ; snout length 6·3 and 6·4, eye diameter 5·5 and 7·2 ; pectoral length 24·2 and 24·0, pelvic length 12·9 and 12·9, last dorsal ray 40·7 and 37·3, pectoral axillary scale 10·9 and 5·1 ; pre-dorsal distance 47·0 and 51·5, pre-pelvic distance 51·0 and 52·0, pre-anal distance 76·0 and 76·5.

Gillrakers less than half length of gill filaments on anterior arch ; anterior hemibranch equal or subequal to posterior hemibranch.

Dorsal iv 11 and 12, pectoral i 14 and 15, anal ii 16 and 20. Abdominal scutes, pre-pelvic 18 and 20, post-pelvic 13 and 12, total 31 and 32.

Pelvic fin base under first or second branched dorsal ray. Pectoral tips just fail to reach pelvic base. Sub-operculum roughly rectangular ; anterior margin of second sub-orbital not clearly defined, but probably vertical, not with oblique lower edge. A recent description of the skull is given by Moona (1964).

Length : 152 mm. (220 mm. Weber and de Beaufort 1913).

Range : Persian Gulf (Bushehr, Hor-el-Hammar), and Gulf of Aden (Tamarida,

Kor Garrieh, Qishn), but no Red Sea records ; elsewhere, Indian Ocean, Malay Archipelago, ? Philippines and China.

Specimens :

2 fishes, 98–152 mm., Bushire (Blegvad material, Z.M.C. C4–5).
1 fish, 142 mm., Shatt-el-Arab, coll. Pietschmann (N.M.V. 4345).

ANODONTOSTOMA Bleeker, 1849

Anodontostoma Bleeker, 1849, *Verh. Bat. Gen.* (*Madura*), **22** : 15 (Type : *Anodontostoma hasselti* Bleeker = *Clupanodon chacunda* Hamilton-Buchanan).

A single species in this area.

Anodontostoma chacunda (Hamilton-Buchanan)
Goaf (Iran)

Clupanodon chacunda Hamilton-Buchanan, 1822, *Fishes of the Ganges* : 246, 283 (Type locality : Ganges estuaries).
Dorosoma chacunda : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 59 (S. of Ras el Mutafs between Lingeh and Quishim).
Anodontostoma chacunda : Fowler 1956, *Fishes of the Red Sea*, **1** : 60 (Indo-Pacific specimens only).

Description : based on two fishes, 118–128 mm., Persian Gulf.

In percentages of standard length : body depth 47·0–50·7, head length 26·0–27·4 ; snout length 5·6–6·1, eye diameter 8·2–8·4 ; pectoral length 23·7–24·5, pelvic length 14·3–14·8, anal base 17·9–19·1 ; pre-dorsal distance 50·5–50·8, pre-pelvic distance 54·0–57·5, pre-anal distance 79·0–82·0.

Dorsal iv 15, pectoral i 15–16, pelvic i 7, anal iii 16–17. Abdominal scutes, 17 pre-pelvic, 10–11 post-pelvic. Gillrakers, 64–65 on lower part of first arch. Scales in lateral series 40–44 (Fowler 1941).

Colour : in alcohol, light brown, darker along back, scale rows marked by paler horizontal lines ; a large black spot (almost equal to eye) a little behind operculum, on a level with eye ; fins hyaline.

Length : 128 mm. (212 mm., Fowler 1941).

Range : Persian Gulf (between Lingeh and Qeshm) ; elsewhere, Indian Ocean to East Indies, Philippines, Hainan, Melanesia.

Specimens :

2 fishes, 118–128 mm., Persian Gulf, col. Blegvad (Z.M.C. C10–11).

ENGRAULIDAE

Four genera found in the Red Sea area, *Engraulis*, *Stolephorus*, *Thrissina* and *Thryssa*, of which the first is represented only by immigrants from the Mediterranean.

KEY TO THE GENERA

1 No abdominal scutes, belly rounded and smooth . . . . . ***Engraulis***
2 Abdominal scutes present :
  a. No post-pelvic scutes . . . . . ***Stolephorus***
  b. Post-pelvic scutes present :
    i. No scutes before pectorals . . . . . ***Thrissina***
    ii. Pre-pectoral scutes present . . . . . ***Thryssa***

ENGRAULIS Cuvier, 1817

Engraulis Cuvier, 1817, *Règne Animal*, **2** : 174 (Type : *Clupea encrasicolus* Linnaeus, designated by Jordan, Tanaka and Snyder, 1913, *J. Coll. Sci. Tokyo*, **33** : 38).
Encrasicolus Fleming, 1828, *Hist. Brit. Anim.* : 183 (Type : *Clupea encrasicolus* Linnaeus).
Austranchovia Whitley, 1931, *Aust. Zool.*, **6** : 311 (Type : *Atherina australis* Shaw).

In addition to the well-known forms of *Engraulis* in temperate waters (Atlantic and Pacific coasts of North and South America, coastal waters of Japan, Australia, and South Africa, and in the Eastern Atlantic and Mediterranean region), I have shown elsewhere that a smaller, tropical form exists off the coasts of West Africa and in parts of the Indo-Pacific (Whitehead 1964c). Small specimens of *Engraulis* are readily mistaken for species of the closely related *Stolephorus*, and because of the reputedly strict antitropical distribution of *Engraulis* such confusion has been responsible for authors overlooking the occasional presence of *Engraulis* from tropical regions in their collections.

From the Red Sea region, however, the only specimens of *Engraulis* which I have found are those recorded by Norman (1927) from Port Said and the Great Bitter Lake. Bleeker's eleven syntypes of *Stolephorus zollingeri* are all *Engraulis* (Whitehead 1964b), but Blegvad's three specimens of *S. zollingeri* from the Persian Gulf are true *Stolephorus*.

Engraulis and *Stolephorus* can be separated by the presence, in the latter, of a pair of triangular fontanelles between the posterior tips of the frontals. These fontanelles, which are narrowly divided in the midline by the anterior extension of the supra-occipital, occur also in *Thrissina* and *Thryssa*, but not in adult *Engraulis*. A second difference between *Engraulis* and *Stolephorus* is in the length of the pseudobranch, which exceeds eye diameter in *Engraulis* but is shorter in *Stolephorus*. Finally, the maxilla in *Engraulis* barely projects beyond the posterior tip of the second (posterior) supra-maxilla ; in most species of *Stolephorus* it projects at least a short distance beyond.

Engraulis encrasicolus (Linnaeus)
(Antchonga)

Clupea encrasicolus Linnaeus, 1758, *Syst. Nat.* ed. 10, **1** : 318 (" Oceano Europaeo ").
Engraulis encrasicolus : Jordan and Hubbs, 1917, *Ann. Carnegie Mus.*, **11** (3–4) : 461 (Port Said) ; Chabanaud, 1932, *Bull. Mus. Hist. nat. Paris*, (2) **4** (7) : 824 (Lac Amer, Suez Canal) ; *Idem*, 1934, *Bull. Mus. Hist. nat. Paris*, (2) **6** (1) : 157 (L. Timsah, Suez Canal) ; Fowler, 1956, *Fishes of the Red Sea*, **1** : 72 (Italian specimens).
Engraulis encrasicholus : (misspelt) Norman, 1927, *Trans. zool. Soc. London*, **23** (3) : 376 (Port Said, Lake Manzaleh, Great Bitter Lake) ; Gruvel and Chabanaud, 1937, *Mém. Inst. Egypte*, **35** : 4 (Suez Canal).
Engraulis anchrassicolus : (error) Gruvel, 1936, *Mém. Inst. Egypte*, **29** : 151 (Suez Canal).

DESCRIPTION : based on the single specimen, 68 mm., recorded by Norman from the Great Bitter Lake ; and on two fishes, 75–93 mm., from Port Said. A good description, and comparisons between samples from different parts of the Mediterranean region, are given by Demir (in press).

In percentages of standard length : body depth 17·9–21·5, head length 26·4–29·2 ; snout length 4·8–5·2, eye diameter 6·5–7·8, maxilla length 20·4–23·2, length of lower jaw 18·5–19·6 ; pectoral length 14·7–17·7, pelvic length 10·2–13·8, length of anal base 14·7–17·5 ; pre-dorsal distance 51·5–54·5, pre-pelvic distance 46·0–51·4, pre-anal distance 68·0–71·0.

Dorsal iii 12, pectoral i 14–15, pelvic i 6, anal ii 15–16. No abdominal scutes, but a single pelvic scute with tapering ascending arms. Scales deciduous. Gillrakers 32–33 on lower part of first arch. Branchiostegal rays 12–13.

COLOUR : in alcohol, upper and lower surfaces brown, broad silvery stripe along flank (width exceeding eye diameter), belly silver to pelvic fin base. Fins hyaline.

LENGTH : 93 mm. (Port Said) ; elsewhere up to 180 mm., Adriatic, Demir (in press).

RANGE : Suez Canal (Great Bitter Lake, but not beyond according to Norman (1927)—to Gulf of Suez according to Tillier (1902)) ; elsewhere, Mediterranean region (Black Sea, Sea of Azov, Mediterranean), Eastern Atlantic from Bergen to Morocco. Eggs (or larvae) from Gulf of Suez reported by Fage (1920) may have been based on a species of *Stolephorus*.

Specimens :

1 fish, 68 mm., Great Bitter Lake (B.M.N.H. 1925.12.31.1).

2 fishes, 75–93 mm., Port Said (B.M.N.H. 1925.9.19.6–7).

STOLEPHORUS Lacepède, 1803

Stolephorus Lacepède, 1803, *Hist. Nat. Poiss.*, **5** : 381 (Type : *Stolephorus commersonii* Lacepède —see Whitehead 1963c, Proposal Z.N. (S) 569, *Bull. zool. Nomencl.*, **20** (4) : 281–284).
Anchoviella : Fowler, 1941, *Bull. U.S. nat. Mus.*, No. 100 : 696 (*non* Fowler 1911).
Amentum Whitley, 1940, *Aust. Zool.*, **9** (4) : 402 (Type : *Stolephorus commersonii* Lacepède).

Note on synonymy.

Elsewhere (Whitehead 1963c) I have shown that the identity of *Atherina japonica* Houttuyn, the second of the two species included by Lacepède in his genus *Stolephorus*, cannot be deduced with certainty. Authors have sometimes considered it a species of round herring and accordingly have either used *Anchoviella* Fowler, an American genus, to take the place of *Stolephorus* for Indo-Pacific species (e.g. Fowler 1941) ; or have proposed a new name (e.g. Whitley 1940). As pointed out by Gosline (1951), the International Commission for Zoological Nomenclature had some years ago (Opinion 93, 1926) designated *Stolephorus commersonianus** Lacepède, an undoubted anchovy, the type of *Stolephorus*. *Atherina japonica* Houttuyn should be considered a *nomen dubium* (Whitehead 1963c).

The genus *Stolephorus* is badly in need of revision and, as in the case of *Sardinella* and *Herklotsichthys*, a full revision may well reduce the number of species at present recognised (e.g. Fowler 1941, 15 species, separated chiefly on scute number, maxilla length and anal position).

*A cheironym for *commersonii*.

KEY TO SPECIES

1 Anal origin under or behind last dorsal ray ; muscular portion of isthmus not reaching to border of branchiostegal membrane.
  a. maxilla pointed posteriorly, projecting beyond second supramaxilla ***S. heterolobus***
  b. maxilla truncate posteriorly, barely projecting beyond second supramaxilla ***S. buccaneeri***

2 Anal origin under dorsal ; muscular portion of isthmus reaching forward beyond hind border of branchiostegal membrane ; maxilla tip pointed, projecting beyond second supramaxilla . . . . . ***S. indicus***

Stolephorus heterolobus (Rüppell)
(Antchonga, Hanen)

Engraulis heteroloba Rüppell, 1837, *Neue Wirbelth., Fische* : 79, pl. 21, fig. 4 (Type locality : Bay of Massaua) ; Martens, 1866, *Verh. zool. bot. Ges. Wien*, **16** : 379 (Koseir).

Engraulis heterolobus : Günther, 1868, *Cat. Fish. Brit. Mus.*, **7** : 392 (Red Sea) ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 596 (Koseir, Red Sea) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 157 (Gischin), 167 (S. Arabia) ; Gruvel, 1936, *Mém. Inst. Egypte*, **29** : 151 (Suez Canal) ; Gruvel and Chabanaud, 1937, *loc. cit.*, **35** : 4 (idem) ; Bertin, 1943, *Bull. Mus. Hist. nat. Paris*, (2) **15** (6) : 389 (Gulf of Suez ; L. Timsah ; Djibouti).

Anchoviella heteroloba : Fowler, 1945, *Sudan Notes and Records*, **26** (1) : 116 (Red Sea).

Stolephorus heterolobus : Bertram, 1948, *Fish. Sultinate Muscat Oman* : 26 (Batinah coast).

Amentum heterolobum : Fowler, 1956, *Fishes of the Red Sea*, **1** : 73 (Buru and Philippine specimens only).

Engraulis commersonianus : Boulenger, 1887, *Proc. zool. Soc. London* : 666 (Muscat) (misidentification) ; ? Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 167 (E. Arabia) (name only ; ? on Boulenger).

DESCRIPTION : based on the holotype, 60·0 mm. standard length, from the Bay of Massawa ; five fishes, 53–55 mm. standard length, from Muscat (Boulenger's *E. commersonianus*) ; six fishes, 44–59 mm., from Ras Imran, Gulf of Aden ; and ten fishes, 59-64 mm., from Dulcuff I.

In percentages of standard length : body depth (15·0, holotype) 14·4–18·2, head length 24·5–29·0 ; snout length 4·7–6·3, eye diameter 6·4–7·7, upper jaw length (21·7, holotype) 21·3–25·9, lower jaw length 15·8–19·5 ; pectoral length 12·2–14·5, pelvic length 7·9–9·5, length of anal base 14·3–19·4 ; pre-dorsal distance 49·5–54·0 (55·5, holotype), pre-pelvic distance 43·6–50·5, pre-anal distance 62·5–67·7.

Anterior tip of muscular portion of isthmus lying well behind margin of branchiostegal membrane ; urohyal with a horizontal, shield-shaped expansion on lower edge immediately in front of the muscular portion of isthmus (Figure 4a). Maxilla tip pointed, reaching to just beyond lower jaw articulation. Anal origin below or behind last dorsal ray.

Dorsal iii 10–11, pectoral i 11–13, pelvic i 7, anal ii–iii 13–15 (15–18 total). Abdominal scutes, 5–6 pre-pelvic only. Scales caducous, 33–34 in lateral series (Fowler, 1956). Gillrakers, upper arch (23 in holotype) 17–20, lower arch 21–25 (26 in holotype).

COLOUR : in alcohol, dark brown upper surfaces, lighter brown lower surfaces, a broad silver lateral band on flanks, wider then eye diameter. Fins hyaline.

LENGTH : 60 mm. (73 mm. Fowler, 1956).

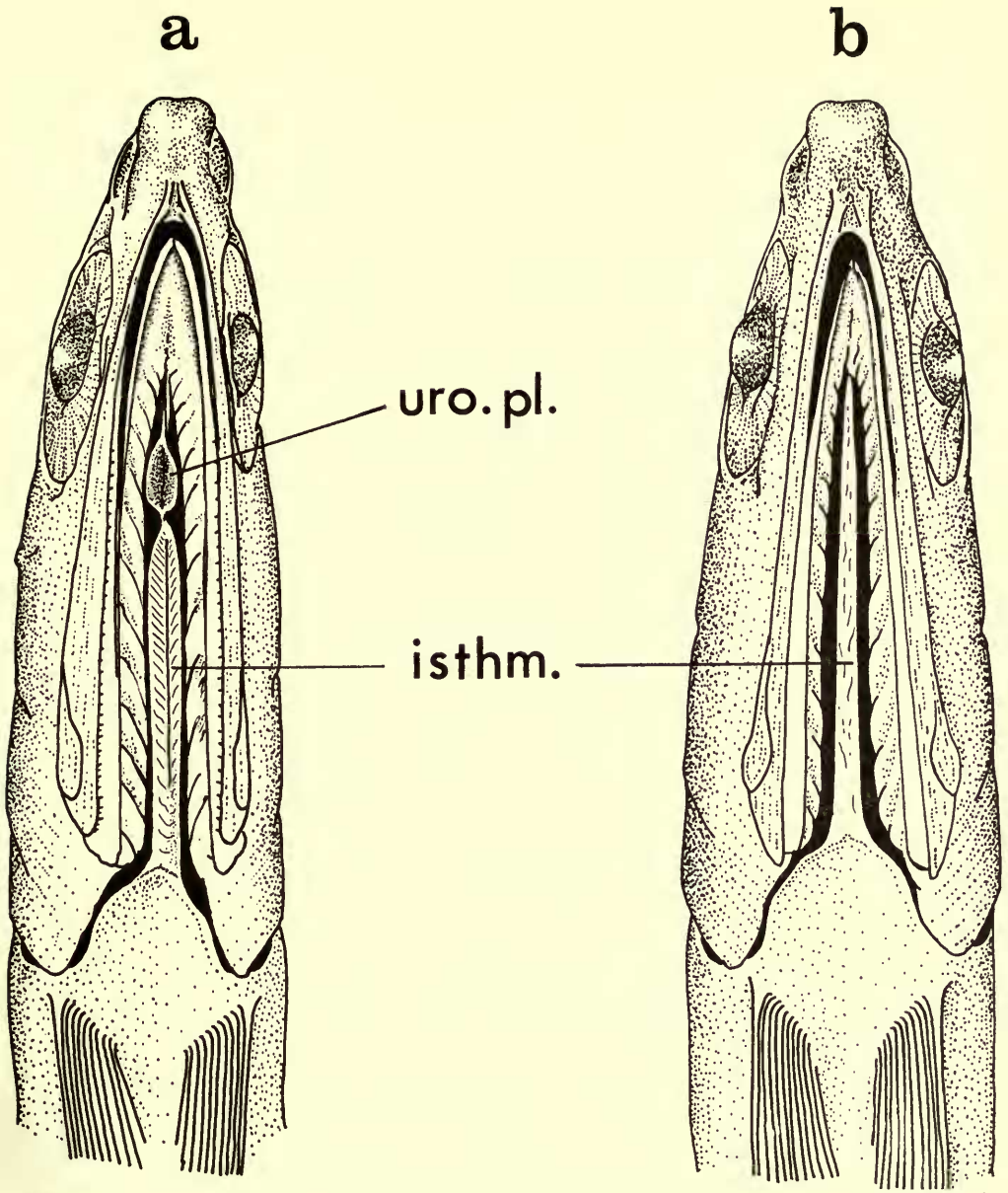

FIG. 4. Ventral view of head in two species of *Stolephorus* showing relative lengths of muscular portion of isthmus and position of ventral expansion on urohyal. a. *S. heterolobus*. b. *S. indicus*.

uro. pl.—urohyal plate. *isthm.*—muscular portion of isthmus.

RANGE : Suez Canal, Lake Timsah, Red Sea (Quseir, Abayil, Kamaran, Massawa, Dulcuff I.), Gulf of Aden (Ras Imran, Ras Antara, Berbera, Djibuti), Gulf of Oman (Muscat), Persian Gulf (Bendar Abbas) ; elsewhere, Zanzibar, Madras, East Indies, Australia.

Specimens :

1 fish, 60 mm., HOLOTYPE of *Engraulis heterolobus* Rüppell, Red Sea (B.M.N.H. 1845.10.29.104).
3 fishes, 62–64 mm., PARATYPES of *E. heterolobus* Rüppell, Massaua (N.-M.F.-I.S. 4715–17).
10 fishes, 53–55 mm., Muscat (Boulenger's *Engraulis commersonianus*) (B.M.N.H. (1887.11.11.302–311).
54 fishes, 33–39 mm., Ras Imran (B.M.N.H. 1963.12.9.36–55).
5 fishes, 51–61 mm., Berbera (B.M.N.H. 1963.12.9.56–59).
6 fishes, 27–29 mm., Ras Antara (B.M.N.H. 1963.12.9.31–35).
2 fishes, damaged, Bendar Abbas, Blegvad material (Z.M.C. 4–8).
13 fishes, 56–62 mm., Dulcuff I., Red Sea (H.U. E57/731).
5 fishes, 43–51 mm., " Arabia, ? Oman " (H.U. 2087/4–5).
2 fishes, 48 mm., Massaua (H.U. E57/769).
4 fishes, 49–58 mm., Cameran, Red Sea, coll. Steindachner (N.M.V. 2757).
1 fish, 51 mm., Abayil, Red Sea, coll. Steindachner (N.M.V. 2756).

NOTE ON MATERIAL EXAMINED : *S. heterolobus* belongs to the group of species in which the anal origin lies behind or below the last dorsal ray. This group includes *S. zollingeri* (Bleeker), *S. celebicus* Hardenberg, *S. pseudoheterolobus* Hardenberg, *S. purpureus* Fowler and *S. buccaneeri* Strasbourg. I have shown elsewhere (Whitehead 1964b) that *S. zollingeri* (and possibly also *S. celebicus*) was based on specimens of *Engraulis*. *S. pseudoheterolobus* was distinguished by Hardenberg (1933) from *S. heterolobus* by its longer maxillary (21·3–22·7 per cent of S.L.) and deeper body (16·1–17·9 per cent of S.L.) ; these figures are, however, almost identical with those given here for *S. heterolobus*. The two remaining species were described from Hawaii.

S. heterolobus differs from all other species in having a small plate-like bony expansion on the lower edge of the urohyal immediately in front of the muscular portion of the isthmus (see Figure 4a). In *S. purpureus* and *S. buccaneeri* there is a similar expansion but it is fleshy and smaller than in *S. heterolobus*. In these three species the muscular, pigmented portion of the isthmus does not extend forward to the hind border of the branchiostegal membrane, as is the case in all other species of *Stolephorus*.

If these two characters, anal position and urohyal shape, have real systematic value, then *S. heterolobus* is most closely allied to species from Hawaii. It is, therefore, of great interest that the following species, *S. buccaneeri*, hitherto known only from Hawaii, should now be recorded from the Red Sea area.

Stolephorus buccaneeri Strasburg

Stolephorus buccaneeri Strasburg, 1960, *Pacific Science*, **14** (4) : 396 (Type locality : Hawaii).
Stolephorus zollingeri (Blkr.) ? : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 61 (Bender Abbas market).
Amentum zollingeri : Fowler, 1956, *Fishes of the Red Sea*, **1** : 73 (on Blegvad).
Amentum commersonii : Fowler & Steinitz, 1956, *Bull. Res. Counc. Israel*, **5** B : 262 (Arabia, Oman?).

Note on synomy.

Blegvad's three hard and shrivelled specimens from the Bender Abbas market closely resemble *S. zollingeri* Bleeker. I would have followed Blegvad's indentification were it not that Bleeker's specimens are in fact a species of *Engraulis* (Whitehead 1964b). The only species of *Stolephorus* with such short, truncated maxillae are *S. buccaneeri* from Hawaii and *S. celebicus* Hardenberg from Java. The types of the latter are lost, but at least one specimen identified as *S. celebicus* from Java in the Leiden Museum is a species of *Engraulis*. The paratypes of *S. buccaneeri*, however, are true *Stolephorus*, having posterior frontal fontanelles retained in the adults (see Whitehead 1964b).

A single specimen collected by Steinitz from ' Arabia ', and two fishes from Suez collected by Steindachner are also placed in *S. buccaneeri*. All these specimens resemble *S. buccaneeri* in having a short muscular portion of the isthmus, not reaching the hind border of the branchiostegal membrane, and a small fleshy expansion on either side of the lower edge of the urohyal, just in front of the muscular part of the isthmus (a precursor of the *S. heterolobus* condition?). I have examined one further specimen of *S. buccaneeri*, a fish of 72 mm. from Durban.

Meristic counts for the Red Sea and Persian Gulf specimens fall within the ranges given by Strasburg (1960) for Hawaiian specimens of *S. buccaneeri*. In proportional measurements they agree or differ only very slightly except in maxilla length, which is a little greater (16·2–19·8 per cent. of S.L. ; *cf.* 14·1–16·8).

The Red Sea and Persian Gulf specimens cannot be separated from Hawaiian specimens at subspecific level on meristic or proportional measurements. Since the number of specimens collected from either area is small, it is possible that *S. buccaneeri* occurs in intermediate areas but has been missed. *S. celebicus* might be this species, but it was described as lacking scutes (a further reason for believing it to have been based on a species of *Engraulis*). Fowler's (1941) specimens of *S. zollingeri* from the Philippines may be this species ; he describes 4–5 abdominal scutes.

Description : based on three specimens 40–50 mm. standard length, from Bendar Abbas ; one fish, 51 mm., from "Arabia" ; and two fishes, 72–79 mm., from Suez.

In percentages of standard length : body depth 15·2–17·7, head length 23·4–26·8 ; snout length 4·3–5·0, eye diameter 6·8–8·1, upper jaw length 16·2–19·8, lower jaw length 15·4–19·1 ; pectoral length 14·2–15·4, pelvic length 7·6–9·2, length of anal base 14·5–16·6 ; pre-dorsal distance 50·4–53·2, pre-pelvic distance 45·4–47·5, pre-anal distance 64·5–68·0.

Anterior tip of muscular portion of isthmus lying well behind margin of branchiostegal membrane. Urohyal with two fleshy flanges on either side of the lower edge just in front of muscular part of the isthmus. Maxilla tip truncate, barely projecting beyond tip of 2nd supra-maxilla, not reaching anterior border of pre-operculum. Anal origin just behind last dorsal ray.

Dorsal iii 12, pectoral i 14–15, anal ii 13–14, pelvic i 7. Abdominal scutes, 4–5 pre-pelvic only. Scales caducous, no count possible. Gillrakers long, slender, 19–24 + 22–34 (higher counts in larger fishes).

COLOUR : in alcohol, light brown with prominent silver lateral stripe, not as wide as eye diameter. Dark horizontal line at bases of upper caudal rays.

SIZE : 79 mm. (Suez) ; 51·5 mm. (Hawaii, Strasburg 1960), 72 mm., Durban.

RANGE : Red Sea (Suez), Persian Gulf (near Bendar Abbas), " Arabia " ; elsewhere, Western Indian Ocean (Durban), Hawaii (Oahu, Niihau).

Specimens :

2 fishes, 72–79 mm., Suez, Red Sea, coll. Steindachner (N.M.V. 2737).
1 fish, 51 mm., " Arabia ", coll. Steinitz (H.U. 2087 [a]).
3 fishes, 40–50 mm., Bender Abbas Market, coll. Blegvad (Z.M.C. 1–3).

Stolephorus indicus (van Hasselt)

Engraulis indicus van Hasselt, 1823, *Alg. Konst-en Letter-Bode*, **1** (No. 23) : 329 (Java).
Stolephorus indicus : Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 62, fig. 27 (copied Day) (near Henjam).
Amentum indicum : Fowler, 1956, *Fishes of the Red Sea*, **1** : 74 (Indo-Pacific specimens only).

DESCRIPTION : based on one fish, 103 mm. standard length, from the Persian Gulf ; three fishes, 76–116 mm., from the Gulf of Aqaba ; four fishes 87–103 mm., from North Massawa Channel ; and one fish, 99 mm., from Eritrea.

In percentages of standard length : body depth 16·9–18·7, head length 22·4–24·7 ; snout length 4·5–5·5, eye diameter 5·8–7·3, upper jaw length 18·2–20·0, projection of maxilla beyond 2nd supra-maxilla 1·7–2·3, lower jaw length 15·2–16·7 ; pectoral length 12·2–13·8, pelvic length 7·6–9·5, length of anal base 15·0–16·1 (18·1) ; pre-dorsal distance 52·4–55·5, pre-pelvic distance 42·2–44·3 (46·2), pre-anal distance (58·0) 60·2–64·0.

Anterior tip of muscular portion of isthmus reaching forward beyond hind border of branchiostegal membrane ; urohyal a simple vertical plate without horizontal flanges on lower edge in front of muscular portion of isthmus (Figure 4b). Maxilla tip pointed, reaching to just beyond anterior border of pre-maxilla. Anal origin below sixth branched dorsal ray.

Dorsal iii–iv 12–13, pectoral i (12) 13–14, pelvic i 7, anal iii 16–18. Abdominal scutes, 4–5 pre-pelvic only. Scales caducous, 35–37 in lateral series (Fowler 1956). Gillrakers long, slender 16–18 + 23–26. Branchiostegal rays 13 (5 fishes).

COLOUR : in alcohol, dorsal surfaces brown, ventral surfaces light brown, sometimes white. A silvery midlateral stripe, not as well-defined as in *S. heterolobus*, sometimes very faint. Fins hyaline.

SIZE : 116 mm. (Gulf of Aqaba) ; " 6 inches " (Fowler, 1956).

RANGE : Red Sea (Horgigo Bay, North Massawa Channel, Mocha, Hanfelu Bay), Persian Gulf (near Henjam), but not recorded from Suez Canal, or the Gulfs of Aden or Oman ; elsewhere, Indo-Pacific from Zanzibar to Formosa, Riu Kiu, Melanesia, Micronesia, Polynesia.

Specimens :

1 fish, 103 mm., near Henjam, Blegvad material (Z.M.C. No. 2).
3 fishes, 76–116 mm., Horgigo Bay (H.U. E61/19).

4 fishes, 87–103 mm., N. Massawa Channel (H.U. E57/730, 1–4).
1 fish, 99 mm., Eritrea (H.U. E57/697).
2 fishes, 35–65 mm., Mokha, Red Sea (N.M.V. 2755).
2 fishes, 69–70 mm., Hanfelu Bay (N.M.V. 2740).

THRISSINA Jordan and Seale, 1925

Thrissina Jordan and Seale, 1925, *Copeia*, No. 141: 30 (Type: *Clupea baelama* Forskål).

T. baelama, the only member of *Thrissina*, differs from species of *Thryssa* (i.e. *Thrissocles auct.*) in lacking scutes in front of the pectoral fins, in possessing a well developed pseudobranch, and in having a free spine in front of the dorsal fin so poorly developed that it is barely apparent. *T. baelama* is nearer to species of *Stolephorus* in its slender body, well-developed pseudobranch and fewer anal rays (27–30 ; cf. 32–47 in species of *Thryssa*), but it differs in possessing post-pelvic scutes. Thus *Thrissina* stands intermediate between *Stolephorus* and *Thryssa*.

Thrissina baelama (Forskål)

(Laaf, Baelama, Rambu, Sardin)

Clupea baelama Forskål, 1775, *Descript. Animal.*: 72 (Type locality : Djidda).
Engraulis baelama : Valenciennes, 1848, *Hist. Nat. Poiss.*, **21** : (26) 35 (Red Sea).
Engraulis boelama : Günther, 1866, *Fishes of Zanzibar* : 123 (Red Sea) ; *Idem*, 1868, *Cat. Fish. Brit. Mus.*, **7** : 393 (" Cosseir ") ; Klunzinger, 1871, *Verh. zool. bot. Ges. Wien*, **21** : 597 (Koseir, Red Sea) ; Günther, 1871, *Proc. zool. Soc. London* : 671 (Red Sea) ; Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 157 (Sheikh Othman), 167 (S. Arabia); Bamber, 1915, *J. Linn. Soc. London*, **31** : 478 (Sudanese Red Sea).
Thrissocles boelama : Tortonese, 1936, *Boll. Mus. Zool. Anat. comp. Univ. Torino*, ser. 3, **45** (63) : 14 (Massaua).
Thrissocles boelana (error) : Fowler, 1945, *Sudan Notes and Records*, **25** (1) : 116 (Red Sea).
Thrissocles baelama : Fowler, 1945, *Sudan Notes and Records*, **25** (1) : fig. 2 ; *Idem*, 1956, *Fishes of the Red Sea*, **1** : 72 (Indo-Pacific specimens) ; Fowler & Steinitz, 1956, *Bull. Res. Counc. Israel*, **5** B : 262 (Oman).

Description : based on ten fishes, 87–105 mm. standard length, from Jibuti and Mukalla; four fishes, 72–98 mm., from the Red Sea ; two fishes, 88–97 mm., from Bandar Kassim (Gulf of Aden) ; and four fishes, 61–76 mm., from Port Sudan.

In percentages of standard length : body depth 21·8–27·3 ; head length 25·8–29·3 ; snout length 4·1–5·7, eye diameter 5·7–7·0, upper jaw length 22·7–26·6, extension of maxilla beyond 2nd supra-maxilla 1·9–2·5, lower jaw length 18·8–22·4 ; pectoral length 15·4–19·1, pelvic length (12·6) 13·1–14·6, length of anal base (23·8) 24·7–28·7 ; pre-dorsal distance 48·0–52·3, pre-pelvic distance 43·0–47·7, pre-anal distance 62·7–70·3.

Pseudobranch well-developed, slightly longer than eye diameter. Maxilla tip pointed, reaching just beyond lower jaw articulation. Anal origin behind last dorsal ray.

Dorsal iii 11–13, pectoral i 12 (13), pelvic i 7, anal iii 27–30. Abdominal scutes, pre-pelvic 6 (7–8), post-pelvic 8–9 (10), total 14–16, absent in front of pectoral fins. Scales caducous, 37–38 in lateral series (Fowler 1956). Gillrakers moderately long and slender, 16–18 (19) + 20–23. Branchiostegal rays 12–13 (14).

Colour : in alcohol, dorsal surfaces dark brown, flanks and lower part of body light brown or silvery. No silver stripe on flanks. Fins hyaline.

Size : 105 mm. (Gulf of Aden) ; 131 mm. (Fowler, 1956).

Range : Red Sea (Jiddah, Quseir, Massawa, Marsa Haleib, Rabigh, Yanbu, Nr. Port Sudan), Gulf of Aden (Bandar Kassim, Djibouti, Mukalla, Sheikh Othman), apparently not recorded from Persian Gulf or Gulf of Oman ; elsewhere, Indo-Pacific region from Zanzibar to Philippines, Melanesia, Micronesia and Polynesia.

Specimens :

19 fishes, 76–105 mm., Jibouti and Mukalla (B.M.N.H. 1963.12.9.1–19).
2 fishes, 86–98 mm., Red Sea, coll. Botta (M.N.H.N. Paris, No. 198).
2 fishes, 88–97 mm., Bandar Kassim (B.M.N.H. 1963.12.9.20–21).
5 fishes, 69–73 mm., Cosseir, pres. Dr. Peters (B.M.N.H. 1865.6.12.4–8).
2 fishes, 72–76 mm., " Red Sea ? " (B.M.N.H. 1882.8.16.54–55).
4 fishes, 61–72 mm., near Port Sudan (B.M.N.H. 1963.12.9.27–30).
2 fishes, 83–93 mm., Rabegh, Red Sea, coll. Steindachner (N.M.V. 1989).
2 fishes, 90–97 mm., Jambo, Red Sea, coll. Steindachner (N.M.V. 1987).
2 fishes, 71–78 mm., Mersa Haleib, Red Sea, coll. Steindachner (N.M.V. 1985).

THRYSSA Cuvier, 1829

Thrissa : *non* Rafinesque, 1815 : Cuvier, 1817, *Règne Animal*, **2** : 176 (Type : *Clupea setirostris* Broussonet, designated by Jordan and Evermann, 1917, *Genera of Fishes*, pt. 1 : 98).
Thryssa Cuvier, 1829, *Règne Animal*, ed. 2, **2** : 323 (Type : *Clupea setirostris* Broussonet).
Thryssus Swainson, 1838, *Nat. Hist. Animals*, **1** : 279 (280) (Type : *Clupea setirostris* Broussonet).
Trichosoma : *non* Rudolphi, 1819 : Swainson, 1839, *Nat. Hist. Animals*, **2** : 292 (Type : *Thrissa hamiltoni* Gray).
Thrissocles Jordan and Evermann, 1917, *Genera of Fishes*, pt. 1 : 98 (Type : *Clupea setirostris* Broussonet).
Scutengraulis Jordan and Seale, 1925, *Copeia*, No. 141 : 30 (Type : *Clupea hamiltoni* Gray).

Note on synonymy.

Thrissa Cuvier 1817 is undoubtedly the correct original spelling, as defined in the International Code for Zoological Nomenclature 1961 (Art. 32 [a]). This being so, *Thryssa* Cuvier, 1829, is an unjustified emendation (Art. 33 [a] [ii]) and becomes an objective junior synonym of *Thrissa* Cuvier, 1817. Unfortunately, the latter was already occupied by *Thrissa* Rafinesque, 1815 (now a junior synonym of *Clupanodon* Lacepède, 1803). *Thryssa* Cuvier, 1829, is therefore, the next available name in the synonymy, and although differing from *Thrissa* by only one letter is not (Art. 56 [a]) a homonym of *Thrissa*. *Thrissocles* Jordan and Evermann cannot, therefore, replace *Thryssa*. The name *Thrissocles* has been widely used until now, but Barnard (1925) used *Thryssa*.

Key to the species of Thryssa

1 Spines on gillrakers of first arch of even length along raker ; gillrakers on lower part of first arch 12–17.
  a. Maxilla not reaching pectoral base ; anal rays 38–43 . . . ***T. hamiltonii***
  b. Maxilla extending to or just beyond pectoral base ; anal rays 43–49 . ***T. purava***
  c. Maxilla extending to beyond pelvic base ; anal rays 34–37 . . ***T. setirostris***
2 Spines on gillrakers of first arch with regular clumps of longer spines ; gillrakers on lower part of first arch 20–23 ; maxilla extending to pectoral base . ***T. vitrirostris***

Thryssa hamiltonii (Gray)

Thrissa hamiltonii Gray, 1832–4, *Illustr. Indian Zool. Hardwicke*, **2** : pl. 92, fig. 3 (no locality).
Engraulis vitrirostris : (part) Blegvad, 1944, *Danish Sci. Invest. Iran*, No. 3 : 60 (specimen No. 3 only—Bushire Harbour).
? *Thrissocles malabaricus* : Menon, 1960, *Rec. Indian Mus.*, **54** : 141 (Persian Gulf).

Note on synonymy

Blegvad's specimen No. 3, recorded as *Engraulis vitrirostris*, is now labelled C4. Although not entirely accurate, Blegvad's anal ray, scute and gillraker counts for No. 3, are closer to those of specimen C4 than to those of specimen C3. Blegvad (p. 61) felt that his No. 3 " might be determined as *E. grayi* Blkr. " (a synonym of *T. hamiltonii*). Both first gill arches are now missing, but Blegvad records 13 rakers (8–10 + 12–14 in *E. hamiltonii*). The short maxilla and high anal count clearly separate this fish from *T. vitrirostris*. There seems little doubt that specimens Nos. 3 and 4 have been wrongly labelled. Menon's record of *T. malabaricus* may have been this species ; no description was given.

Description: based on a single specimen, 97 mm. standard length, from Bushire Roads.

In percentages of standard length : body depth 27·7, head length 23·7 ; snout length 3·7, eye diameter 6·2, upper jaw length 24·0, projection of maxilla beyond 2nd supra-maxilla 6·9, lower jaw length 17·7 ; pectoral length 19·6, pelvic length 8·4, length of anal base 34·8 ; pre-dorsal distance 53·0, pre-pelvic distance 41·0, pre-anal distance 62·0.

Line of jaws when mouth closed set at an angle of about 30° to the horizontal. Maxilla tip not reaching base of pectoral fin. Pseudobranch not visible externally. Anal origin just behind last dorsal ray.

Dorsal with small free spine in front, iii 11, pectoral i 11, pelvic i 7, anal iii 39. Abdominal scutes, pre-pelvic 17, post-pelvic 11. Scales caducous, 43–45 in lateral series (Fowler 1941). Gillrakers, both first arches missing (13 on lower arch—Blegvad 1944), gillraker spines not with clumps of longer spines. Vertebrae 45 (X-ray count).

Colour : in alcohol, uniform pale brown, fins hyaline. Humeral venules with a few scattered melanophores.

Length : 97 mm. (225 mm. Fowler 1941).

Range : Persian Gulf only (Bushehr Harbour) ; elsewhere, Indo-Pacific region from India to Korea and to Queensland.

Specimens :

1 fish, 97 mm., Bushire Harbour, Blegvad's *Engraulis vitrirostris* No. 3 (Z.M.C. No. 4).

Thryssa purava (Hamilton-Buchanan)

Clupea purava Hamilton-Buchanan, 1822, *Fishes of the Ganges* : 238, 382 (Type locality : Ganges estuaries).
Thrissocles purava : Misra, 1947, *Rec. Indian Mus.*, **45** : 117 (Hor-el-Hammar).
Engraulis vitrirostris : (part), Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 60 (specimen No. 4 only : Bushire Roads).

Note on synonymy.

As discussed above, Blegvad's specimens Nos. 3 and 4 have been wrongly labelled. Blegvad (p. 61) considered the possibility that his other specimens might be *T. purava*, but felt that gillraker and anal ray counts did not support this. In Blegvad's specimen No. 4 (i.e. specimen now labelled C3, the largest fish in this batch), the low number of gillrakers (10 + 19) and the high anal count place this fish in *T. purava*.

Description : based on a single fish, 158 mm. standard length, from Bushire Roads.

In percentages of standard length : body depth 25·2, head length 22·8 ; snout length 3·8, eye diameter 4·7, upper jaw length 23·5, projection of maxilla beyond 2nd supra-maxilla 7·0, lower jaw length 17·0 ; pectoral length 19·2, pelvic length 8·7, length of anal base 36·0 ; pre-dorsal distance 51·5, pre-pelvic distance 41·0, pre-anal distance 62·0.

Line of jaws when mouth closed set at an angle of about 45° to the horizontal. Maxilla tip reaches pectoral base. Pseudobranch not visible superficially. Anal origin under last dorsal ray.

Dorsal with small free spine in front, iii 10, pectoral i 11, pelvic i 7, anal iii 41. Abdominal scutes, pre-pelvic 15, post-pelvic 10. Scales caducous, 35–40 in lateral series (Fowler 1941). Gillrakers short with spines becoming larger at tips, 10 + 19 ; vertebrae 46 (X-ray count).

Colour : in alcohol, uniform light brown with paler midlateral stripe. Fins hyaline. Humeral venules with a few scattered melanophores.

Length : 158 mm. (Persian Gulf).

Range : Persian Gulf only (Bushehr) ; elsewhere, India, East Indies, Bonin Islands, Melanesia (Fowler 1941).

Specimens :

1 fish, 158 mm., Bushire Roads, Blegvad's *Engraulis vitrirostris* No. 4, largest specimen (Z.M.C. C3).

Thryssa vitrirostris (Gilchrist and Thompson)

Lacheh, Kowa (at Bendar Abbas)

Engraulis vitrirostris Gilchrist and Thompson, 1908–11, *Ann. S. Afr. Mus.*, **6** : 201 (Localities : Natal ; inner Harbour, Durban) ; Blegvad, 1944, *Danish Sci. Invest. Iran*, pt. 3 : 60 (all but specimens No. 3 and 4 ; S. of Bushire, Hor Musa, near Hormuz, Jabrin).

Thrissocles vitirostris : (misspelt) : Fowler, 1956, *Fishes of the Red Sea*, **1** : 71 (on Blegvad).

Description : based on 12 fishes, 65·5–132 mm. standard length, from the Persian Gulf and Gulf of Oman.

In percentages of standard length : body depth 24·0–28·6, head length 24·7–27·3 ; snout length 4·2–5·2, eye diameter 5·3–7·5, upper jaw length 28·0–30·6, projection of maxilla beyond 2nd supra-maxilla (7·8) 8·8–10·0, lower jaw length 18·5–20·4 (22·5) ; pectoral length 18·1–20·5, pelvic length 7·5–9·1 ; length of anal base (28·2) 31·3–33·8 ; pre-dorsal distance 50·5–53·2, pre-pelvic distance 43·5–46·2, pre-anal distance 61·5–65·5.

Line of jaws (when mouth closed) at an angle of about 30° to the horizontal. Maxilla tip reaches pectoral base. Pseudobranch not visible. Anal origin behind last dorsal ray.

Dorsal with small free spine in front, iii 10–11, pectoral i 11–12, pelvic i 7, anal iii 33 (1 fish), 34 (6), 35 (2), 36 (3). Abdominal scutes, 16–17 (19) pre-pelvic, 10–11 (12) post-pelvic, total 26–28 (31). Scales caducous, 44 in lateral series (Fowler, 1941). Gillrakers, 14–17 + 20–21 (23), moderately long and slender, gillraker spines arranged in clumps of longer spines interspersed by shorter spines. Branchiostegal rays 11–12. Vertebrae 43 (1 fish), 44 (8), 45 (3).

Colour : in alcohol, uniform, light brown, with lighter band along flank. Fins hyaline. Humeral venules with well-marked lines of melanophores. Gill arches bright orange in life in Indian specimens (Dutt 1961b).

Size : 132 mm. (Persian Gulf) ; 168 mm. (Fowler, 1941).

Range : Persian Gulf (Bushehr, Hor Musa, Jabrin, Hormuz), Gulf of Oman (Blegvad lists several station numbers sited along the northern shores from which specimens were taken but not kept), not from Gulf of Aden or Red Sea ; elsewhere, South Africa, India.

Specimens :

12 fishes, 66–132 mm., Persian Gulf, Blegvad material (Z.M.C. C1–2, 5–14).

Note on material examined : In meristic characters, these fishes fall well within the range given by Dutt (1961b) for Indian specimens.

Thryssa setirostris (Broussonet)

(Soti)

Clupea setirostris Broussonet, 1782, *Ichth.*, **1** : no pagination, pl. 2 (Type locality : Pacific near Tanna I., Society Group) ; *Idem*, 1788, *Tabl. Ichth.*: 186, pl. 76, fig. 218 (Red Sea).
Engraulis setirostris : Steindachner, 1907, *Denkschr. Akad. Wiss. Wien*, **71** (1) : 157 (Gischin).
Thrissocles setirostris : Fowler, 1956, *Fishes of the Red Sea*, **1** : 71 (Indo-Pacific specimens).

Description : based on ten fishes, 85–120 mm. standard length, from Mukalla and Jibuti ; and two fishes, 118–134 mm., from the Red Sea.

In percentages of standard length : body depth 25·0–27·6, head length 20·9–23·4 ; snout length 3·4–4·4, eye diameter 5·0–6·5, upper jaw length 51·5–58·0, lower jaw length 12·7–14·2 ; pectoral length (16·4) 18·3–22·2, pelvic length 11·6–13·3, length of anal base 29·5–36·0 ; pre-dorsal distance 50·8–55·0, pre-pelvic distance 40·7–44·1, pre-anal distance 56·0–63·2.

Maxilla tip reaching to beyond pelvic base. Lower jaw with ascending coronoid process, not found in other species of *Thryssa*.

Pseudobranch not visible. Anal origin just behind last dorsal ray.

Dorsal with small free spine in front, iii 11–12 (13), pectoral i 11–12, pelvic i 7, anal iii 31–34. Abdominal scutes, 16–18 pre-pelvic, 8–9 post-pelvic, total 24–27. Scales caducous, 40–42 in lateral series (Fowler, 1941). Gillrakers moderately long, blunt, 6 + 11–12. Branchiostegal rays 10.

Colour : in alcohol, uniform light brown, humeral venules with lines of melanophores. Fins hyaline.

Size : 134 mm. (Red Sea).

Range : Red Sea (no localities given), Gulf of Aden (Djibouti, Qishn, Mukalla), not recorded from Persian Gulf or Gulf of Oman ; elsewhere, Indo-Pacific region, from Natal to China, Queensland, Polynesia.

Specimens :

21 fishes, 68–120 mm., Mukalla and Jibuti (B.M.N.H. 1963.12.9.60–80).
20 fishes, 31–53 mm., Berbera, Gulf of Aden (B.M.N.H. 1963.12.9.81–90).
2 fishes, 118–134 mm., Red Sea, coll. Boré (M.N.H.N. 5887).

DISCUSSION

Both the Red Sea and the Persian Gulf are large, partially enclosed bodies of water with rather special hydrological conditions (chiefly high temperatures and high salinities). Both would be expected to contain a relatively large proportion of endemic species. In fact, Marshall (1950) found 15 out of the 114 species he collected from the Gulf of Aqaba to be either endemic to the Red Sea or distinguishable in minor ways from the species known in the Indian Ocean. Gohar (1954) estimated that some 15 per cent. of the 450 species recorded from the Red Sea were endemic, but pointed out that about 80 per cent. of Red Sea species have a wide distribution in the Indo-Pacific region. Amongst the species listed here, the degree of endemism is very low and the single endemic, *Nematalosa arabica*, is not recorded from the Red Sea itself, but from the Gulf of Aden. But, unlike the typical coral reef fishes, the elopoid and clupeoid species are in general wide-ranging, pelagic fishes not given to forming small isolated communities within which genetical isolation and divergence could occur. Thus, of the 31 species listed here (Table I), the overwhelming majority are known not only from the Indian Ocean, but range eastwards to the East Indies, the Philippines, in some cases to China, even to Hawaii. What contribution, therefore, can such a list make to the understanding of the faunal relationships of the Red Sea fishes ?

The first and most obvious feature of the list of species given in Table I is the absence of any Mediterranean species in the Red Sea. The only two Mediterranean clupeoids which have emigrated southwards through the Suez Canal are *Sardinella maderensis* and *Engraulis encrasicolus*, and no certain Red Sea record exists for either, even from the Gulf of Suez. More striking perhaps is the fact that, of the 17 elopoid and clupeoid genera listed here for the Red Sea area, only one (*Sardinella*) has a member in the Mediterranean fauna. It is worth noting, however, that of these 17 genera, only two others have populations in temperate waters, *Dussumieria* and *Etrumeus*, and it is these two alone which have managed to penetrate into the Eastern Mediterranean. One can conclude from this that, amongst the elopoid and clupeoid fishes, the Red Sea is now populated by tropical, mainly widespread Indo-Pacific species which are probably unlikely to establish populations in the Eastern Mediterranean. If, at any stage in its history, the Red Sea was colonised by Mediterranean clupeoid fishes, then these either failed to become established or were

subsequently eradicated by geological events. The Mediterranean species *Sardinella aurita*, which has a wide distribution elsewhere in the world, is replaced by *S. longiceps* in the Indian Ocean, and even this species has not yet been recorded from the Red Sea.

In comparison with the Red Sea-Persian Gulf area, the Mediterranean region has no elopoids at all, and a poor clupeoid fauna (*Alosa, Sardina, Sprattus, Clupeonella, Sardinella*, and *Engraulis*). It is also poor in comparison with the Western North Atlantic (elopoids : *Elops, Megalops, Albula, Dixonina ;* clupeoids : *Etrumeus, Clupea, Sardinella, Harengula, Opisthonema, Alosa, Brevoortia, Odontognathus, Pristigaster, Ilisha, Rhinosardinia, Dorosoma, Neopisthopterus, Chirocentrodon, Jenkinsia, Engraulis, Anchoa, Anchovia, Anchoviella*). If, therefore, the Mediterranean was colonized by elopoid and clupeoid fishes from the Indian Ocean *via* the Red Sea, these have since died out. In fact the Mediterranean clupeoid fishes (except for the endemic *Clupeonella*) are identical, or closely related, to genera and species in the Eastern North Atlantic. Thus, whatever connections existed between the Red Sea (and Indian Ocean) and the Mediterranean in past geological times, the present elopoid and clupeoid fishes offer virtually no evidence in either area of this link nowadays.

Recent migration between these two areas *via* the Suez Canal has been mainly from the Red Sea to the Mediterranean rather than *vice versa*. Two Red Sea clupeoid species have reached the Mediterranean, *Dussumieria acuta* and *Etrumeus teres* ; as already stated, only two Mediterranean clupeoids have penetrated as far as Lake Timsah and the Bitter Lakes. It would seem that colonization of a relatively hyperthermal and hypersaline environment has been easier for Indian Ocean elopoids and clupeoids passing into the Red Sea, than for Mediterranean clupeoids.

A further point raised by the list of species given here is the curious appearance of *Stolephorus buccaneeri*, otherwise known only from Hawaii. Unfortunately, few critical comparisons exist of species or forms from the extreme east and west of the Indo-Pacific region. But such figures as are recorded for *Dussumieria acuta* (Whitehead 1963b) suggest a parallel with *S. buccaneeri*. Thus Bertin (1943a) commented on the similarity of *D. acuta* from the two ends of the Indo-Pacific, and described this phenomenon as " *evolution centrifuge* ", postulating that the ancestral forms had been forced outwards by developing, competitive forms. Populations of *S. buccaneeri* might, of course, exist in the intervening area, unrecorded or misidentified. There are no other species listed here with such a marked discontinuity in their distribution. *S. heterolobus* was not recorded by Fowler (1941) from India, but I have now examined a Madras specimen in this museum.

Speculation based on the absence of records is unsatisfactory, and a comparison between the species listed here from the Red Sea and those from the Persian Gulf would probably give an incorrect picture of colonization of the two areas. According to Table I, only seven species are common to both areas and, on the basis of the present, rather inadequate records, it appears that each area has nine or ten species not found in the other. Since many of these nineteen species are widespread in the Indo-Pacific region, their absence from one or other area must, for the time being, be

considered due to inadequate collections. Two of the Red Sea species absent from the Persian Gulf (*Elops machnata* and *Sardinella jussieu*) have been recorded from the Gulf of Oman ; similarly, two of those Persian Gulf species (excluding *Hilsa* spp.) absent from the Red Sea have been recorded from the Gulf of Aden (*Sardinella bulan*, and *Nematalosa nasus*). Important in this connection are the seasonal variations in hydrological conditions and any thermal or other gradients which may occur in either area. Thus, some fishes enter the Red Sea from the Gulf of Aden only during the winter months, others penetrate only as far as the ' sill ' north of Bal-el-Mandab (the true oceanographic beginning of the Red Sea), and others again become increasingly rarer towards the northern end of the Red Sea (see Gohar 1954). Obviously, a mere list of recorded species will be misleading unless supported by hydrological data.

In conclusion, it can be said that the Western Indian Ocean is much poorer in both species and genera of clupeoid fishes than is the Eastern Indian Ocean and Indo-Malayan Archipelago. The Red Sea-Persian Gulf elopoids and clupeoids have been derived, therefore, from an already rather meagre faunal assemblage. Evidence that the Red Sea or the Persian Gulf should be considered as special units within the Indo-Pacific region is not provided by the elopoid or clupeoid fishes.

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TABLE I

Records of elopoid and clupeoid species from the Red Sea and adjacent regions.

	Mediterra-nean Sea	Suez Canal	Red Sea	Gulf of Aden	Gulf of Oman	Persian Gulf
Elopidae						
Elops machnata			×	×	×	
Albulidae						
Albula vulpes			×	×		
Chirocentridae						
Chirocentrus dorab			×	×	×	×
Dussumieriidae						
Dussumieria acuta	×	×	×	×		×
Etrumeus teres	×		×			
Spratelloides gracilis		×	×			
Spratelloides delicatulus			×	×		
Clupeidae						
Herklotsichthys punctatus		×	×	×	×	×
Herklotsichthys vittatus			×	×		
Sardinella bulan				×	×	×
Sardinella longiceps				×	×	
Sardinella maderensis	×	×				
Sardinella jussieu		×	×	×	×	
Sardinella fimbriata			×			×
Sardinella sirm			×	×		
Hilsa kelee				×		×
Hilsa ilisha						×
Opisthopterus tadoore					×	
Ilisha indica						×
Nematalosa arabica				×	×	
Nematalosa nasus				×		×
Anodontostoma chacunda						×
Engraulidae						
Engraulis encrasicolus	×	×				
Stolephorus heterolobus		×	×	×	×	×
Stolephorus buccaneeri			×			×
Stolephorus indicus			×			×
Thrissina baelama			×	×		
Thryssa vitrirostris					×	×
Thryssa setirostris			×	×		
Thryssa hamiltoni						×
Thryssa purava						×
TOTAL 31	4	7	17	17	10	16